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ERRATA.

Page.	Line.				
3	14	*For*	that	*read*	than
8	10	—	phœnomena	—	phænomena
46	18	—	Clanſthal	—	Clauſthall
47	2	after *fumes* put a colon			
73	15	*For*	double	*read*	doubly
ib	21	—	common	—	commonly
155	4	—	abdominial	—	abdominal
144	13	—	CASE XV	—	CASES XV and XVI
170	11	—	than	—	that

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It were well indeed, if on all theſe ſubjects the rules of art had attained to that degree of correctneſs and preciſion, which is the genuine characteriſtic of ſcience. But if we compare what has been performed with what is profeſſed, we ſhall be forced to acknowledge, that the art has neither made a progreſs, nor received an attention in proportion to its dignity and importance. That the whole buſineſs of diet, that buſineſs which occupies a portion of the daily thoughts of every individual, is at beſt but imperfectly underſtood, we may conclude from the contradictory directions which are frequently given to the ſick by medical practitioners of the beſt reputation. The treatment of infancy, the health of which ſo greatly depends on a proper regulation of diet, is even at preſent principally confided to the moſt ignorant females;—a certain proof that medical practitioners have not univerſally attained that ſuperior ſkill and preciſion in theſe matters, which, when attained, will infallibly command the public confidence.

Nor do the properties of water, I mean as it is preſented to us by nature for our domeſtic uſes, ſeem to be more perfectly underſtood. We do not find medical writers giving any other directions with regard to the choice of what is ſalubrious and the rejection of what is noxious, that what, if juſt, are obvious enough to the apprehenſion of the bulk of mankind. That water ſhould be clear, light, without ſmell and taſte, and fit for the boiling of leguminous ſeeds, are the rules that have been handed down to us for many centuries, and I do not know that any eſſential improvements have been as yet made upon them by modern ſcience and experience.

If indeed we confide in the doctrine of a celebrated teacher, even the precautions which may be deduced from theſe rules are quite unneceſſary. 'I lived', ſays he,* 'for many years in a large city in which the waters very univerſally employed were very hard, and although ſofter waters were within their reach, the moſt part of the people uſed only the hard. But among this people I found no endemic diſeaſes; and at leaſt none that I could impute to the water they drank, and certainly none that I did not find as frequent in a city which I have alſo practiſed in for many years, whoſe inhabitants very univerſally uſed no other than a very ſoft water.'

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* Cullen's Materia Medica, vol 1. p. 406.

‘ Phyſicians have entered into ſtill ‘ nicer diſtinctions of common water,—but ‘ there ſeems to be little foundation for ‘ theſe diſtinctions. Uncommon impregna‘ tions of ſome of them may upon occaſion ‘ take place; but we believe ſuch will al‘ ways be apparent enough to prevent their ‘ being uſed: and with regard to their com‘ mon ſtate it is ſtill enough, that no im‘ pregnations which are not ſenſible to the ‘ ſight, taſte or ſmell are of ſo much conſe‘ quence as to deſerve our attention and ‘ choice in their employment.’—

‘ We conclude that the nice examina‘ tions that have been made of the ſtate of ‘ Common Waters, were very commenda‘ ble; but now they are made, they do not ‘ lead me to think that much nicety is ne‘ ceſſary in the choice of them: and we do ‘ not find that there is any foundation for ‘ ſuppoſing that any of them can produce

‘ the diſeaſes alleged to be endemic in cer-
‘ tain countries.’

Notwithſtanding the weight which is due to ſo great an authority, I cannot be perſuaded that ſo many phyſicians, from the age of Hippocrates to our own days, have been utterly deceived in attributing diſeaſes to the qualities of common water. The only deduction to be juſtly made from the fact alleged by Cullen is, that the wholeſomeneſs of waters does not depend on their hardneſs or their ſoftneſs. But the experience of an individual, or even of many individuals, however extenſive, is quite incompetent to the deciſion of a queſtion of this nature. We find, from a compariſon of bills of mortality, that there is in fact a ſurpriſing difference in the healthineſs of different places, which cannot be accounted for by the difference of their ſituation, or by any marked peculiarity in the modes of life of the inhabitants. On the other hand, it muſt be granted, that no peculiar varieties in the qualities of the waters, ſufficient to account for theſe differences, have hitherto been remarked. But I will venture to aſſert that the art of analyſis is as yet in a ſtate of ſo great imperfection, that many impregnations of waters have totally eſcaped obſervation; and, particularly, that many metallic impregnations, the effects of which on the body, it is probable, are infinitely more powerful than thoſe of the ſubſtances which have been moſt attended to, have entirely eluded the reſearch of the chemiſt. If we reflect on the acknowledged fact, that the compoſition of the Bath waters is at preſent but very imperfectly known, and that ingenious men ſtill indulge themſelves in conjectures on the nature of the ſubſtances to which they owe their activity, I ſhall not be accuſed of temerity in making this aſſertion. In our preſent ſtate then of ignorance and uncertainty, that the different ſalubrity of many places *may* in a great degree depend on the qualities of the waters which are in common uſe, ſeems to be, though the proof muſt be acknowledged to be deficient, a conjecture as probable as any that can be adduced. No other cauſe is more fixed, permanent and widely diffuſed; its effects then may be expected to be uniform, conſtant and adequate to the ſolution of the phœnomena.

Nor is it neceſſary that we ſhould ſearch for peculiar endemics ſuppoſed to be produced by theſe qualities. It is not perhaps that peculiar and ſpecific diſeaſes are ſo excited, but that thoſe which are common to the whole ſociety are more frequent or more fatal. Where there is an increaſed mortality, there muſt be an increaſe of general morbid ſuſceptibility, and a greater maſs of diſeaſe will be generated, under whatever names individual caſes may be arranged and claſſified.

Cullen himſelf condemns the waters which are turbid, or which contain impregnations diſtinguiſhable by our organs. But the waters of many ſprings, which, during the winter ſeaſon, are limpid and taſteleſs, become turbid in the dryneſs of ſummer; and many contract a bitteriſh taſte: they ſeem to differ, in theſe different ſeaſons, in their ingredients being only more or leſs diluted with the elementary fluid. Shall we ſay then, that that which is noxious in one form can be made innocent merely by dilution? If to be devoid of taſte and ſmell be ſufficient to prove a water to be perfectly ſalubrious, I know not why weak ſolutions of tartarized antimony, or even of arſenic may not be ſo eſteemed; and why the world may not be induced to believe that ſuch ſolutions may be habitually taken with impunity.

Thoſe who occupy themſelves in the cultivation of this branch of natural philoſophy are not then, I truſt, to be charged with miſemploying their time in uſeleſs and frivolous purſuits. Till it is certain that the art of analyſis has arrived at the utmoſt perfection, it ſeems an unwarrantable preſumption to neglect acquiring the moſt correct notions in our power of the properties of that fluid, which is ſo abundantly applied to the daily uſe of our ſpecies. Such was the opinion of an eminent phyſician, the authority of whoſe name may be oppoſed to that of Cullen, particularly on a ſubject to which he had paid much attention. On the ſubject of the Bronchocele he ſays,* as I apprehend with perfect truth, ‘ I think that the cauſe ‘ of the Bronchocele is to be ſought for in ‘ the nature of the water which is uſed, the ‘ perfect chemical inveſtigation of which is ‘ a great deſideratum.’

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* Heberden Commentarii de Morborum Hiſtoriâ et Curatione. p. 72.

But my preſent object is to enquire, not ſo much into the common condition of water, as into the accidental contaminations it may contract; though I propoſe, at a future time, to make the varieties of its common condition the ſubject of a fuller inveſtigation. Granting however for the preſent that water in its ordinary condition is ſufficiently pure for the purpoſes of life, have we any reaſon to think that it can receive a contamination from the ſubſtances with which it is frequently brought into contact? Of all theſe ſubſtances LEAD is that which is moſt commonly uſed, and is preferred to other metals, on account of its cheapneſs, the eaſe with which it fuſes, and its great ductility, fitting it to be readily moulded into convenient forms. But theſe advantages may be eſteemed rather to be a public calamity, if the metal communicate to the fluid its own deleterious properties. The queſtion then whether water in its ordinary condition has a power of diſſolving lead, is, from the frequent uſe which is made of it, of the firſt importance to ſociety.

The general practice of the country ſeems to have decided this queſtion in the negative. Whatever may be the ſuſpicions of ſome, they have not been ſufficiently ſtrong to produce much effect on the public mind, nor ſcarcely any influence on our domeſtic arrangements. Many towns are principally ſupplied by water conveyed from a diſtance by leaden pipes; families preſerve it in ciſterns formed of lead; ſome public breweries, I am told, have ſimilar ciſterns on a large ſcale, in which the water is allowed to ſtagnate; pumps ſo formed are put down every day, in every ſituation and in all ſorts of wells; and I know not that any one aſks the queſtion, whether or not, by theſe arts, a large portion of the public is daily and hourly conſuming a quantity of the moſt virulent and inſidious poiſon.

One of the effects of common water on this metal muſt have been known from the time of its introduction into general uſe, it being ſo obvious that it cannot eſcape the notice of the leaſt attentive obſerver. This is the formation of a white matter on its ſurface: this matter is univerſally allowed to be in part a ſpecies of ceruſſe or oxyd of lead, and it muſt be made at the expenſe of the metal. This was the reaſon, which induced the ancients to condemn leaden pipes for the conveyance of water, it having been remarked, that perſons, who ſwallowed the ſediment of ſuch water, became affected with diſorders of the bowels.* There is a great diverſity in the corroſive powers of different waters. In ſome places the uſe of leaden pumps has been in part diſcontinued, from the expenſe entailed upon the proprietors by the perpetual want of repair. Dr. Wall has remarked the ſtrong corroſive powers of the waters in the city of Worceſter, which he attributes to their hardneſs.* Dr. Falconer in his laborious eſſay on the Bath waters remarks, 'that the (leaden) ciſtern which ſerves as a 'reſervoir for the spring at its firſt riſe, appears plentifully corroded on its inſide by the 'long furrows which are viſible on every 'part of it.'† In Warwick, the place of my own reſidence, many ſprings are very corroſive, in ſo much that one of my neighbours ſagaciouſly ordered his plumber to make the lead of a pump, for one of his own tenements, of double the uſual thickneſs, to ſave the charge of repairs: becauſe, according to his own remark, 'the Warwick water is ſo hard 'that it eats the lead away very ſoon.' It is well known that water pipes gradually wear out, and inſpection will commonly prove to us, that the waſting of their ſubſtance has been occaſioned by the loſs of matter from the inſide of the pipes. I have myſelf ſeen a ſmall leaden ciſtern, in which pump-water had been kept, with many furrows and hollows in the bottom. This was the ſecond ciſtern which in the courſe of leſs than ten years had been nearly deſtroyed.

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* Sir G. Baker in Medical Tranſactions. vol. 1. p. 280.

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* Med. Tranſact. vol. 2. p. 420.

† Falconer on Bath Waters. vol. 1. p. 299.

This corroſive power of ſpring water has not been well accounted for by chemical writers. The conjectures that have been made to explain it are neither probable in themſelves, nor ſupported by experiment. The vague manner in which it is noticed by Fourcroy evince, that this learned chemiſt is far from having arrived at any clear and accurate notions concerning it. His words are theſe; 'Lead ſuffers no alteration from pure water; 'the metal does not ſeparate the component 'principles of the fluid: yet the ſides of

‘ leaden water pipes are covered over with ‘ a whitiſh cruſt, or a kind of ceruſſe, the ‘ production of which is owing, no doubt, to ‘ the action of the various matters, contained ‘ in the water, upon the metallic ſubſtance.’* Had the learned writer known which of *the various matters contained in the water* poſſeſſed this corroſive power, he would certainly have mentioned it. It is of peculiar moment to determine this queſtion, as the ſolvent power (ſuppoſing there to be ſuch) is connected probably with the ſame principle.

But if corroſion were the only action exerted by common water upon lead, the miſchief occaſioned by its uſe would be of ſmall extent, and the effect of unpardonable negligence only. We ſhould be put to no further trouble, than to be careful, that the water we uſe is perfectly pellucid, which in the far greater number of inſtances is the caſe of thoſe, with which this metal has been kept in contact. Mixture and ſuſpenſion could be the only effects of this power, which being mechanical properties might be removed by methods purely mechanical. Suffering the ſuſpected matter to be depoſited by reſt, or the uſe of a filtering ſtone would enſure the ſalubrity of the water. But is this corroſive power the only one which in fact water poſſeſſes? Is common water, or is it not, a true ſolvent of lead, and that not accidentally, but from the nature and eſſence of its conſtituent principles? This queſtion has not eſcaped the attention of phyſicians, and ſome have beſtowed no ſmall pains to determine a point of ſuch obvious magnitude. But unhappily their experiments have led to concluſions the reverſe of the truth, and thus have contributed rather to lull mankind into a falſe ſecurity, than to awaken them to a neceſſary ſuſpicion and to inculcate wiſe precautions.

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* Fourcroy’s chemiſtry. vol. 2, p. 484.

Such are the experiments of the learned phyſician, to whoſe labours the world is infinitely indebted for having detected the cauſe of the colic, endemial in Devonſhire, and ſome other cyder counties, and having proved beyond the poſſibility of doubt, that it proceeded ſolely and uniformly from a ſolution of lead, either accidental or nefarious, in the cyder of the country. He informs us, that he kept various waters in contact with lead for two months; he examined alſo ſome water (hard water certainly, from the appearances deſcribed, though this is not expreſsly mentioned) kept by Dr. Heberden on bits of lead for twelve years; but in none of theſe inſtances could he find, by the application of the ſubſtances uſed by chemiſts as teſts of the preſence of this metal, any traces of the lead having been diſſolved. 'Hence it appears,' he adds, 'that lead is 'not capable of ſolution in water even in 'twelve years, but only of mixture and ſuſ-

'penſion.'* The experiments were doubtleſs correct, though the inference is utterly erroneous. Other perſons, though ſatisfied from their own obſervations of the accuracy of the experiments, have doubted of the juſtneſs of the concluſions. Dr. Percival in particular has conjectured what will appear to be the matter of fact. Though he failed to prove the ſolvent power of water, he could not diveſt himſelf of the ſuſpicion that certain waters poſſeſs ſuch a property; and he acutely adds, 'that the volatile tincture of 'ſulphur' (the ſubſtance which he uſed as a teſt) 'may not perhaps in every inſtance 'be a certain criterion of the preſence of 'this poiſonous mineral.'† Dr. Falconer too was perſuaded that the Bath waters, which in the compoſition of their fixed contents differ very little from common hard water, diſſolved the lead of the ciſtern, and gave a proper caution againſt its uſe.

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* Sir G. Baker, in the Medical Tranſactions. vol. 1. p. 295.

† Percival's Eſſays med. and experimental. vol. 1. p. 223. Ed. 1788.

Since the period of theſe inveſtigations, chemiſtry has aſſumed a new form, and more accurate and delicate teſts have been diſcovered for the detection of metallic ſubſtances. That which is now commonly uſed for the diſcovery of lead held in ſolution, poſſeſſes extreme ſenſibility, and is free from ſome of the defects of thoſe formerly employed. But ſtill its operation is ſo limited, that its introduction has not encreaſed our knowledge of the action of water, ſince though it can detect quantities infinitely more minute, its efficacy is confined nearly within the ſame range as that of the ſubſtances formerly in uſe. The moſt recent information which I have met with on the ſubject is contained in an elegant and uſeful compilation, the work of Mr. William Henry of Mancheſter, entitled an Epitome of Chemiſtry. As the knowledge and talents of this gentleman are univerſally acknowledged, his ſtatement may doubtleſs be received as a faithful repreſentation of the preſent ſtate of public information on this intereſting queſtion.

The following are the paragraphs to which I allude. ‘ Lead is occaſionally found ‘ in ſufficient quantity to be injurious to ‘ health in water, that has been kept in ‘ leaden veſſels; and ſometimes even in ‘ pumps, in conſequence of the metal being ‘ uſed in the conſtruction of the pump.— ‘ Lead may be diſcovered by adding to a ‘ portion of the ſuſpected water about half ‘ its bulk of water impregnated with ſul- ‘ phurated hydrogen gas. If lead be preſent ‘ it will be manifeſted by a dark brown or ‘ blackiſh tinge. This teſt is ſo delicate that ‘ water condenſed by the leaden worm of a ‘ ſtill tube is ſenſibly affected by it.’

‘ It may alſo be detected by a ſimilar ‘ effect enſuing on the addition of ſulphurets ‘ of ammonia or potaſh.’ †

If this ſtatement were correct, the preſent inveſtigation would indeed be a ſuperfluous labour, and people, if injured by ſuch ſolutions, could blame their own raſhneſs and inertneſs only. But unfortunately, this account is completely erroneous; and in this caſe error, which is obſtinately confident, is infinitely more dangerous than ignorance, which may be needleſsly ſcrupulous. I have now examined a great number of waters under theſe circumſtances, and in one inſtance only have I been able to detect lead by the proceſs directed above.* That inſtance was of water contained in a ciſtern in a private houſe, and collected alſo in a ciſtern at a common reſervoir, before its diſtribution to different houſes. Ciſterns are expoſed to a variety of accidental impurities. They are dangerous then, independent of the ſolvent powers of water, and cannot be adduced in proof of ſuch a power. The noted colic of Amſterdam, deſcribed by Tronchin, was occaſioned by leaves falling and putrifying in leaden ciſterns filled with rain water: but rain water does not corrode lead, and its ſolvent power is at leaſt hardly ſenſible. * The inſtance related by Van Swieten,† of a whole family

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† Henry's Epitome of Chemiſtry, 2d Edit. p. 183.

* I have met, ſince this was written, with a ſecond inſtance of the ſame kind. It was in the water of the New River preſerved in a ciſtern.

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* There is ſaid to be a piece of lead, preſerved in the Leverian Muſeum, with holes in it formed by rain water. It was given by Judge Blackſtone, and the fact is atteſted in his hand writing. But as the air muſt have been here a powerful agent likewiſe, this fact does not prove much. However, rain water, I believe, has a ſmall ſolvent power; though from its not producing any white incruſtation; there is no appearance of corroſion: and its effects is ſo ſlight, as to be ſcarcely diſcernible within a moderate compaſs of time.

† Van Swieten ad Boerhaave Aphoriſm. 1060 Comment.

afflicted with the colic of Poitou, from ſuch a ciſtern, may have been of the ſame nature. And I do not doubt that the very ſtriking caſe of diſeaſe from the ſame cauſe, recorded in the Medical Commentaries, proceeded more from ſome foulneſs in the ciſtern than from the ſolvent power of the water. * In this inſtance, the officers of a packet veſſel uſed water out of a leaden ciſtern, whilſt the men uſed the ſame water, except that theirs had not been in contact with lead. The conſequence was, that all the officers were ſeized with ſymptoms of the colic of Poitou, and all the men continued healthy. The writer of this account expreſsly informs us, that a ſolution of alcaline ſulphuret added to this water occaſioned a copious dark precipitate. From this circumſtance and from the ſuddenneſs and ſeverity of the conſequent diſeaſe, I conclude that an acid

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* See Duncan's Med. Commentaries. Dec. 2. 1794.

had been formed in the ciſtern which, more than any qualities of the water itſelf, had diſſolved the lead. Theſe inſtances of diſeaſe are, I am ſenſible, utterly deſtitute of novelty; but the careleſſneſs of the bulk of mankind to theſe things is ſo great, that to repeat them again and again cannot be wholly uſeleſs.

But the circumſtances of pump waters and of all others which are not expoſed to accidental impurities are quite diſtinct from theſe caſes, and ſubject to different laws. It is poſſible that acid matter may ſometimes exiſt in common ſprings;* but if we except the carbonic acid, which has no action on lead, it is ſo rare an occurrence, that it may be fairly neglected in a reſearch into its ordinary properties.* In all common waters the ſulphurated hydrogen gas detects nothing; nor do I know that a teſt properly ſo called, of lead ſo diſſolved, applicable to all circumſtances, is to be found. But in every water that I have hitherto examined I find indubitable ſigns of the metal having been diſſolved. The proceſs in ſome inſtances is removed only by a ſtep or two from that directed by Mr. Henry: in others ſtill greater trouble is neceſſary to its detection. This is my apology, if apology be not miſplaced, for ſubmitting theſe Reſearches to the public eye. The queſtion ſtill remains eſſentially on the ſame footing, on which it was left by Baker and Heberden, and it ſeems that the public require, not ſimply to be enlightened on a matter of the greateſt concernment to the ſtability and the comfort of human life, but to be reſcued from pernicious errors, ſanctioned by the moſt reſpectable authorities.

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* It often happens that impurities drain into wells from the ſurface of the earth, as the water of ſtagnant pools, the filth of ſewers &c. Such impurities will contaminate the water with matter foreign to its own nature, and perhaps with acid matter. Theſe accidents form an additional reaſon for caution in the uſe of metals in machinery connected with water.

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* I need hardly obſerve that I here underſtand acid matter uncombined with alcaline, earthy or metallic ſubſtances.

The demonſtration of theſe aſſertions I reſerve for the concluſion of theſe reſearches, which will comprehend the chemical experiments on which they are founded. By theſe experiments I hope to eſtabliſh, beyond the poſſibility of further diſpute, the ſolvent power of all* common water; and, as far as in me lies, to point out the agents concerned in the proceſs, and indicate the operations neceſſary to the detection of the metal. One proof only may be mentioned in this place.

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* By *all* I of courſe mean all that I have been able to examine. There are ſome, which may not poſſeſs this power, and I believe I have met with ſuch: but they are uncommon, and I have hitherto met with but one among thoſe which are actually uſed in contact with lead, concerning the ſolvent power of which I am ſtill in doubt.

It is that I have myſelf extracted from a pump water, fortuitouſly ſelected, a portion of lead in its proper metallic form.

Aſſuming then for the preſent this ſolvent power as an eſtabliſhed fact, the firſt and moſt obvious enquiry is, whether the impregnation has any evident and ſenſible operation on the human ſyſtem. The deleterious effects of this ſlow and inſidious poiſon are at preſent ſo univerſally acknowledged, that it is quite unneceſſary to adduce any arguments in proof of its noxious power. The antients were, upwards of two thouſand years ago, as well aware of its poiſonous nature, as we are at the preſent day, and indeed appear to have been much more apprehenſive of its virulence, and ſcrupulous in the application of it to purpoſes of domeſtic economy. Their precautions may have been occaſionally carried to an unneceſſary length: this was the natural conſequence of the imperfect condition of their chemical and philoſophical knowledge. When men were unable to detect poiſonous matters with certainty, to be over ſcrupulous in their uſe was an error on the right ſide. But their authority on this ſubject is of no little weight, as the very defects of their philoſophy would make them more careful in their obſervations of facts. The moderns, on the other hand, in part perhaps from an ill founded confidence in their chemical ſkill, and a conſequent inattention to a careful and continued examination of effects, have fallen into an oppoſite error; and the general uſe which has been made of this metal for pumps, water-pipes, reſervoirs and the complicated machinery which in many ſituations is requiſite for the ſupply of water, has frequently, I am perſuaded, been very miſchievous, and in very numerous inſtances the unſuſpected cauſe of death.

The moſt noted of the conſequences of the poiſon of lead is the excitement of the ſaturnine colic, known commonly by the name of the colic of Poitou. In this diſeaſe, the ſtomach and inteſtines are affected with ſpaſmodic pains, as acute as any that human nature can ſuſtain: and in the abſence of theſe with a dull and obtuſe pain, from which the patients are ſeldom free. The diſeaſe returns in paroxyſms of the ſame ſeverity as at firſt, between which there are conſiderable intervals of eaſe; and theſe paroxyſms often recur with great violence, though there is every reaſon to believe, that the poiſoned materials have been previouſly diſcontinued for a great length of time. The paroxyſms of violent pain are of unequal duration, laſting ſometimes for a few days, at others for a month together; and are apt to return every third or fourth month. The limbs at length become benumbed and paralytic; which ſymptom more commonly attacks the ſuperior than the inferior extremities. The pains of the bowels affect the patient, it may be one year, it may be ten, before the palſy accedes. In the progreſs of the diſeaſe the paroxyſms become more frequent, the fleſh waſtes, the appetite and ſtrength decay, and death is the certain conſequence, unleſs the cauſe of the diſeaſe be detected ſufficiently early, and wholly removed.

Such are the principal ſymptoms, (it were uſeleſs to go more in detail) of a moſt cruel diſeaſe, in the form it commonly aſſumes, when excited by the habitual introduction into the ſyſtem of minute portions of lead. It has moſt frequently been obſerved to ariſe from the uſe of ſophiſticated liquors; and I have extracted this account from the deſcription of our moſt reſpectable writers, that the unprofeſſional reader may compare their ſtatement with the caſes to which he is referred.

As there is no ground for ſuſpecting that this train of ſymptoms can be excited by any other external cauſe than that here aſſigned, whenever theſe appearances occur; it may be juſtly concluded, that the poiſon has been by ſome means or other introduced. In the caſe of the ſolution by water, it muſt be granted, that the impregnation is, perhaps in all caſes, much weaker than the ſolution in adulterated liquors; and, except in the caſe of ciſterns, the evidence of which is, for the reaſons already aſſigned, of doubtful authority, I know not that any inſtances are on record of the diſeaſe having been occaſioned by the uſe of ſuch water. But this, I believe, has been chiefly owing to the total want of ſuſpicion, in the minds of practitioners, of the exiſtence of ſuch a cauſe. The bowels are liable to ſo many and ſuch ſevere pains from a variety of cauſes, that if there is no paralytic affection to excite an alarm, a poiſon is the laſt thing that is ſuſpected, unleſs the employments or habits of the patient direct the attention of the medical attendants to this point. It may be readily collected from the accounts of candid writers, that more commonly the detection of the cauſe has led them to the explication of the ſymptoms, than the ſymptoms to the determination of the cauſe. The ſilence then of writers I regard chiefly as a proof, that the moſt ſevere diſeaſes of the inteſtines have frequently been aſcribed to a miſtaken origin.

To myſelf there have occurred two inſtances of ſaturnine colic in its genuine form from the uſe of the water of a leaden pump. They are detailed in the Caſes XII and XIII. The diſeaſes mentioned in Caſe II were probably of the ſame kind, with the addition of the proper and peculiar ſymptom of palſied ſuperior extremities. The inſtances here adduced receive a ſtrong corroboration from the ſtriking facts related in Caſe V on the weighty authority of Sir G. Baker.

In individual inſtances of this affection, as in moſt others, there are infinite ſhades of difference. That which I have deſcribed varies in many particulars from the form in which it affects plumbers, painters and other workmen in lead, who are occaſionally expoſed to the influence of large quantities of the poiſon within ſhort periods of time; and is the type to which particular caſes approximate in a greater or leſs degree, but not without much variety and irregularity in many of the appearances. In moſt caſes the pains of the bowels are the prominent feature; in a few, the paralytic affection. For this reaſon, Caſe IV may juſtly be eſteemed an inſtance of this diſeaſe, though there were never any very acute pains throughout the courſe of it.

If accidental circumſtances ſhould make the ſufferers ceaſe to uſe the contaminated water, the diſeaſe being in its beginning and, it may be, for ſeveral years mild and irregular, may have excited no great notice, nor be ever traced to its proper ſource, if the attention have not been particularly directed to this point. An affection trifling in its magnitude and unattended by any ſerious conſequences, when no longer felt, will perhaps be no more thought of. But ſuch affections muſt, nevertheleſs, be deemed inſtances of the genuine ſaturnine diſeaſe, as much as thoſe of the greateſt ſeverity. Well authenticated relations have come to my knowledge of ſeveral, who have had pains of the bowels during the uſe of theſe waters, which ceaſed on a change of reſidence; and of others who always ſo ſuffer by reſiding in ſituations, where leaden pumps or pipes are known to be common. But I do not poſſeſs any (except thoſe which will be detailed below) with which I am ſo circumſtantially acquainted, as to juſtify a particular narration. I am perſuaded, however, that ſuch examples are ſo far from being rare, that it requires only attention to the point in queſtion to detect them frequently. Apothecaries are more likely to be familiar with theſe examples than phyſicians, who are commonly conſulted, only on dangerous emergencies.

The venerable and Hippocratic Heberden has the following remarks in treating on the ſubject of the ſaturnine colic.* 'I have never obſerved the acute 'ſpecies of this colic, except among painters, 'plumbers or other artificers, who had been 'expoſed to lead or to its fumes.† In the

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* Heberden Comment. p. 333.

† Had this learned phyſician, who, in the work I have quoted, confines himſelf to the relation of his own experience, (an experience—the reſult of a practice of half a century) made his obſervations in the country, he would

‘ chronic ſpecies, the lead inſinuates itſelf ‘ by ſome ſecret paſſages into the ſtomach, ‘ which calamitous circumſtance often cauſes ‘ great and inſurmountable difficulty in curing ſuch patients. For neither knowing ‘ nor ſuſpecting how this poiſon can be introduced into the ſyſtem, and being therefore unable to guard againſt it, unleſs ſome ‘ accident ſhould prevent the perpetual renovation of the miſchief, it is impoſſible ‘ for the patient, by any ſkill, to be reſtored ‘ to his former health.’

This account amounts, I think, to an acknowledgement, that this experienced and

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have certainly added contaminated cyder to the cauſes of the acute ſpecies of ſaturnine colic. This peſt is by no means extinct, in ſpite of the labours of Sir G. Baker. An inſtance of it has occurred to myſelf, of great ſeverity and terminating in palſy, a few months ago. It is quite idle to hope to eradicate the miſchievous cuſtoms, which occaſion ſuch dreadful evils, by the feeble arms of reaſon, unaided by legiſlative regulations.

accurate obſerver had ſeen caſes of diſeaſes, and ſome of them even fatal, which he judged to be ſimilar to thoſe ariſing from lead, and which he ſuſpected to have had the ſame origin, without having been able to trace the ſource of the poiſon. Many ſuch muſt have occurred to others, though it may be, that, from the want of equal powers of diſcrimination, the ſame ſuſpicions may not have ariſen. Is it inconſiſtent with candour to ſuppoſe, that miſled by the reſult of his own experiments, from which he had inferred that the water *muſt* be innocent, he neglected enquiries which would have unfolded the myſtery, though they would have led him to doubt of the accuracy of his former concluſions? Preconceived opinions are apt to exert an irreſiſtible force on the moſt candid minds; and I know not how an obvious truth could eſcape the penetration of ſuch an enquirer, without duly eſtimating the weight of their influence.

It is a point of much practical importance to diſcriminate theſe ſaturnine pains of the bowels, from thoſe ariſing from obſtructions of the inteſtines, from common colics, and from cramps and ſpaſmodic pains of theſe organs. Many of theſe affections emulate in ſeverity the moſt acute paroxyſms of the true ſaturnine diſeaſe, or have many ſymptoms in common with it. This diſcrimination is neceſſary for a two-fold reaſon: firſt, that the detection of the cauſe may lead to its removal, without which it cannot be hoped, that any permanent and eſſential relief can be obtained; and ſecondly, becauſe the proper treatment of ſaturnine pains is materially different from that of common bowel complaints. To remove obſtruction and reſolve inflammation are the chief indications in moſt of the ordinary diſeaſes of the bowels, and by purſuing theſe with ſufficient ſteadineſs, conſiderable advantage is frequently gained. But the operation of lead on the ſyſtem is powerfully ſedative and debilitating, and directly adverſe to exuberant action. Hence in the moſt acute form of the ſaturnine diſeaſe, opium, (which is ſtrongly ſtimulant on the arterial ſyſtem) is adminiſtered, with ſafety and advantage, in quantities much larger than can be borne in moſt other diſeaſes; bleeding, which is imperiouſly requiſite in inflammations of the inteſtines, is here rarely admiſſible; and cathartic medicines are uſeful, only ſo far as they ſupport or excite inteſtinal action, and remove or prevent unnatural and morbid accumulations.* The pains, of which I am now treating, participate in the nature of thoſe of the proper ſaturnine colic, or to ſpeak more juſtly, are the very ſame, except in degree; and they are ſtill more adverſe to ſtrong and repeated evacuations, from the exhauſtion of the vital powers produced by the previous flow, ſilent and unheeded operation of the poiſon on the conſtitution. Opiates united to laxative medicines, cordials, and tonics may be frequently admiſſible and neceſſary, which in common bowel complaints would be more detrimental than uſeful; whilſt the remedies, which are often ſerviceable in the latter diſeaſes, will produce little or no benefit in the ſaturnine pains. The ſmall relief obtained by common modes of treatment, or even the injurious tendency of them, if purſued too far, are circumſtances, which may give an attentive obſerver an inſight into the nature of theſe pains, and excite his ſuſpicions of their cauſe, if he were previouſly uninformed of it.

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* See Warren, Of the Colica Pictonum, in Med. Trans. vol. 2. p. 68.

But the Colic of Poitou is not the only form under which the poiſon of Lead manifeſts its deleterious qualities on animal bodies; and I confeſs that medical practitioners in general ſeem to me to entertain ideas much too confined of its powers. Though this diſeaſe has been well known for many ages, and is deſcribed by ſome of the earlieſt writers of antiquity, yet our predeceſſors entertained no diſtinct notions of the neceſſary connection exiſting between it and its exciting cauſe. Lead, though acknowledged to be one of its cauſes, was not ſuppoſed to be the only one; which diſcovery (it is indeed one of great practical importance) is chiefly due to the ſagacity of our countryman Sir G. Baker. This diſcovery has, I apprehend, in a degree diverted the minds of phyſicians, from conſidering, whether or not this be the only effect of the poiſon, and from minutely enquiring what others it is apt to occaſion, which though leſs common, are not by any means unuſual, and with which it is their duty to be well acquainted.

Certain facts render it probable that lead does not operate entirely through the medium of the circulation, nor by nervous ſympathy; but alſo topically, affecting the part to which it is immediately applied, more than the other parts of the body.* Pewterers and printers, who handle lead very much, particularly when hot, are ſubject to palſies, and other derangements of the nervous ſyſtem; but we do not find that they are afflicted with colics.† The ſtriking efficacy of ſaturnine applications may be regarded as a proof of the ſame aſſertion.—Such applications have no morbid influence on theſe parts; the ſtate of inflammation under which they commonly labour (the ſtate which it is intended to counteract) may be itſelf the antidote to the poiſon. But if it be true, that the primary action of lead is upon the part to which it is applied, it follows, that the ſaturnine colic is not to be eſteemed to be of the nature of a ſpecific diſeaſe, the regular offspring of this poiſon, in whatever form or manner it be applied to the body: it is merely the conſequence of its having been brought into contact with the ſtomach and inteſtines in the firſt inſtance, a circumſtance, which, in the way in which it is uſually received, muſt of neceſſity take place.

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* This ſeems to have been the opinion of the celebrated Hoffman. His words are, 'Cum ſucco lymphatico ad 'nervos, tendines, ligamenta delatæ, in anguſtiſſimis illo'rum tubulis ex facili quoque hærent, et ibidem ſtagnant, 'tam obſtruendo tam irritando, dolores, ſpaſmos, ſpirituum 'animalium interceptiones et inde paralyſes et contracturas 'producunt. Falſum enim eſt, in pareſi vel contracturâ 'ventris doloribus ſuperveniente, per *conſenſum adfici* '*nervos*, vel *ipſam peccantem materiam ex primis viis* '*per nervos ad partes extremas deferri.*' Hoffman opera pathologico-practica. p. 433. Halæ 1738.—De metallis mortiferis.

† Medical Muſeum. vol. 3, p. 415.

But there are matters which have the power of ſheathing and defending the *primæ* *viæ* from its action; and in this way the saturnine colic will be prevented, nor will the bowels be more affected than the other parts of the ſyſtem. The evidence of Dr. Cremer, recorded by Sir G. Baker,* goes directly to eſtabliſh this point; and it is ſo important to the right underſtanding of the nature of ſaturnine diſeaſe, that I cannot forbear quoting it at length. ‘ Oſterhout, he ſays, is the ‘ place of reſidence of a great number of ‘ potters, who are conſtantly employed in ‘ glazing earthen veſſels. Having practiſed ‘ phyſic here fifteen years, I never obſerved ‘ among theſe men one inſtance of the colic ‘ of Poitou; indeed very rarely any affection ‘ of the bowels. Their exemption from this ‘ malady ſeems to be entirely owing to the ‘ large quantities of cheeſe, butter, and fat ‘ bacon, which is their common food. It ‘ is, however, obſervable, that, though theſe

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* Medical Tranſactions, vol. 2, p. 457.

'poiſonous effluvia are enervated with reſpect to the *primæ viæ,* yet very few of 'theſe men are free from diſorders of the 'breaſt; but are ſubject to coughs, hoarſeneſs, aſthma, and ſometimes ſpitting of 'blood.'

This reaſoning is very convincing, as it is well known, that the artiſans employed in the glazing of pottery are commonly afflicted with this cruel malady. The ſame is true of all who are expoſed to the fumes of the metal, which is no other than the oxyd in ſo fine a powder, as to be ſuſpended and float in the atmoſphere. Among the ſmelters of Derbyſhire the complaint is frequent, and is vulgarly called *the belland.* * In the German mine-towns, Harzgerode in the principality of Anhalt, Clanſthal and Cellerfeld in the Upper Harz, it is a ſpecies of endemic, among all the claſſes of workmen, who are expoſed to the metallic fumes, * ſo much is applied to the fauces, and paſſes with the ſaliva into the ſtomach, as to excite the colic in its moſt tremendous form, and followed by its moſt diſaſtrous conſequences. From the evidence of Dr. Cremer, combined with theſe well known facts, I conclude, that to the production of the ſaturnine colic, it is neceſſary that the metal have been applied immediately to the ſtomach and inteſtines, and that it be not involved or combined with any matter, which can diminiſh its direct action upon theſe membranes. †

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* Percival's Eſſays. v. 1. p. 458.

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* Hoffman de metall. morbif. p. 431.

† If this hypotheſis be juſt, no dependence can be placed on the accounts given by ſome writers of colics having been cauſed by the external uſe of ſaturnine applications, as lotions, cataplaſms, &c. The ſubject is expoſed to ſo many deceptions, that it requires much ſtronger evidence to eſtabliſh the fact intended to be proved by theſe ſtatements, than any hitherto adduced. Whilſt, however, I exclude nervous ſympathy, as a proximate cauſe of ſaturnine colic, I would not be underſtood as ſuppoſing it to have no influence on the production of any of the ſymptoms.

Nor is this the only requiſite: it is eſſential moreover that the poiſon be applied with a certain force, the reſult of its quantity; a quantity not abſolutely the ſame in all habits, for this is contradicted by every day's experience; but of the ſame relative power upon different conſtitutions. Let us ſuppoſe that a grain, taken daily for three months, will in a given conſtitution excite the colic. Half a grain taken daily for ſix months will be the ſame abſolute quantity; but it does not follow, that this will excite the colic, nor even if the whole quantity taken be increaſed ſtill farther, by continuing the habit for a longer time. In ſome perſons, it is true, the ſmallneſs of the doſe may be compenſated by the accumulation cauſed by the continuance of the habit. The examples I have produced are a ſufficient proof of the fact. But in the great majority of caſes it will be otherwiſe, and the diſeaſe excited will aſſume a different form. This is analogous to the operation of other ſubſtances on the body. It may not be eaſy to give a ſatisfactory reaſon for theſe varieties, in our preſent limited knowledge of the laws of animal life. But well known and authentic facts put it beyond a doubt, that theſe varieties take place.

The ſaturnine colic is not endemial in Devonſhire or the other cyder counties during the whole year, but is confined to thoſe months when the liquor is ſtill new, crude, and the fermentation incomplete. When the liquor becomes fine, the noxious matter in a great meaſure ſeparates, and is carried to the bottom of the veſſel, as the feculencies ſubſide. Tartar is generated during the vinous fermentation, the acid of which uniting with the lead forms a ſalt, ſcarcely, if at all ſoluble in water; and hence the purification which the liquor receives. But though this ſalt is inſoluble in water, it is otherwiſe in regard to vinegar; this acid difſolves a ſmall quantity. No cyder, nor, I believe, any wine is deſtitute of a portion of vinegar. If therefore the liquor has been once contaminated during the firſt ſtages of fermentation, it is impoſſible for it ever to become pure; except by proceſſes, which would render it unfit for drinking.*

Thus that the colic is only endemial whilſt the cyder is new, is not owing to the liquor having been entirely diveſted of the ſaturnine impregnation, but to the quantity of the poiſon having been ſo much diminiſhed as to be no longer able to excite this peculiar diſeaſe. That the liquor is on this account become wholeſome, I preſume there are few who will be inclined to believe. But what is the form and ſymptoms of the diſeaſes, which, in this condition it occaſions, has not, as far as I know, been particularly deſcribed by medical writers.

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* See Fourcroy, Memoire ſur la nature du Vin lithargyrè, in the Hiſtoire de l'Académie Royale for 1787.

We have, however, a very ſatisfactory account by Zeller, as quoted by Sir G. Baker,* concerning the effects of wine impregnated with litharge, on ſome of thoſe people who drank only ſmall quantities of it. He obſerves 'Thoſe who uſe this liquor daily or 'very often, but not in quantities large 'enough to cauſe intoxication, receive no 'immediate injury from it, but by ſlow de'grees ſuffer various ſymptoms of diſeaſe; 'as theſe are trifling in the beginning they 'diſregard them, and have not recourſe to 'medicine; but ſucceſſively, they perceive 'a pain of the left hypochondrium, a weight 'of the ſtomach, inflation and (*tabem*) a 'waſting of the fleſh.' Theſe effects, though in appearance leſs ſevere than the ſymptoms of ſaturnine colic, are in their conſequences equally formidable, and in the end equally fatal.

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* Medical Tranſactions. vol. 1, p. 260.

I have premiſed theſe obſervations, as I hope they throw ſome light on the action of the ſaturnine poiſon; and as they enable me to give a ſatisfactory anſwer to a queſtion, that has been frequently propoſed to me, in the form of an objection to my ſentiments concerning the noxious power of theſe waters. If, it is aſked, this leaden machinery be really ſo miſchievous as is ſuppoſed, how happens it that the ſaturnine colic is not common over the whole kingdom, and endemial in thoſe places, where this machinery is in common uſe? The objection is certainly ſo far well founded, that it muſt be acknowledged, that the ſaturnine colic, though probably much more frequent than is commonly ſuppoſed, is but of rare occurrence, nor are even the pains of the bowels, which participate of its nature, by any means frequent, regard being had to the great number of perſons, who are in the daily habit of uſing ſuch waters.

There are two reaſons which may be given for this fact. The firſt is the minuteneſs of the doſe. In my aſſay of a water, which I ſuſpect to contain much more lead than is common, I calculate that the quantity diſſolved is little more than a tenth of that, which has been ſaid to be contained in wine adulterated by litharge.

A ſecond obſtacle, and one which is perhaps ſtill more powerful, is the peculiar manner in which the metal is combined, as it is found in theſe ſolutions. This is not the place to enter at large upon this ſubject: it is enough at preſent to obſerve, that it is involved more or leſs completely in all of theſe waters with a matter, which ſeems to be of a vegetable nature. This union is in many caſes ſo perfect, as to require the application of powerful chemical agents to diſſolve the combination, and exhibit it under its common forms and relations. Thus it would appear, that the ſtomach and inteſtines are defended from its immediate action, in ſome caſes totally, in all partially; and thus are the pains and ſpaſms, which are the conſequences of this immediate action, prevented.

For each of theſe reaſons, to conſider only the operation of lead on the *primæ viæ*, is to have a very imperfect view of its powers; it is neceſſary, if we would entertain juſt notions of the ſubject, that we take a far wider range, and examine its influence under all its modifications, and on all the parts and functions of the body. It is my buſineſs then to enquire in this place, what other diſeaſes, independent of the ſaturnine colic, it is apt to excite, when gradually introduced into the ſyſtem. But here, I fear, we ſhall receive but a faint and glimmering light from medical authority. It is commonly acknowledged as one of the parents of chronical and lingering diſeaſes; it has been ſuppoſed to operate as a ſlow poiſon; and even it has been aſſerted, that in ſome countries it has been made ſubſervient to ſuch nefarious purpoſes. Happily our manners have exempted us from any knowledge of the conſequences of ſuch unprincipled attempts; and it may be ſafely aſſerted in general, that we are ſtill very imperfectly acquainted with the forms which the maladies engendered aſſumes. What theſe are, —what the places which would be aſſigned to them in nosological ſyſtems,—whether they are permanent and invariable—or whether they differ in different habits, or in ſucceſſive ſtages in the ſame habit,—on theſe and many other intereſting queſtions connected with the ſubject, little or no light has as yet been thrown. How indeed can it be otherwiſe? The cauſe itſelf, except when the effect produced has been confined to one regular ſeries of ſymptoms, viz. colic and palſy, has almoſt always eſcaped obſervation: it is no wonder then, that the effects have been involved in equal obſcurity, and paſſed over in ſilence.

The few obſervations, which my limited opportunities have enabled me to make, I have accurately and faithfully detailed. Theſe, I hope, may have their uſe in exciting the ſerious attention of phyſicians and of the world in general to an object, which involves the health and comfort of ſuch numbers of perſons. Though the inſtances I have adduced of its deleterious power are by far too few to juſtify any broad and general concluſions on the nature of the diſeaſes produced, they are enough to prove abundantly that the evil is of an evident and palpable magnitude. I hope they may ſerve as the foundation of a uſeful building: it is the duty of thoſe, who poſſeſs the advantage of a wider range of experience than myſelf, to erect the ſuperſtructure. I cannot pretend to have diſcovered any ſure diagnoſtic ſymptom, or train of ſymptoms, by which diſeaſes from this cauſe may be with certainty diſtinguiſhed; and from which the cauſe itſelf may be detected and removed. Still there will be found conſiderable reſemblances in ſome features of the caſes to be related; and I hope they may in ſome meaſure ſerve to aſſiſt and guide others in their inveſtigations.

If the diſeaſe put on the genuine form of ſaturnine colic, there needs only a faithful enumeration of the ſymptoms to prove its nature and its origin; nor is the demonſtration imperfect, though it ſhould terminate fatally. But in an argument of the nature of that with which we are now concerned, fatal caſes are hardly admiſſible; as inferences drawn from ſuch muſt be in their nature rather vague and conjectural. There is only one method of aſcertaining the truth, and of eſtabliſhing, with the force of a moral and practical demonſtration, that the effect is aſſigned to its juſt and legitimate cauſe. It is neceſſary, that the diſeaſe in queſtion have been of ſome conſiderable duration; that the innate powers of the ſyſtem have ſeemed unequal to its cure, and that medicine, applied by perſons not ſuppoſed deficient in ordinary ſkill and diſcernment, have failed to afford any permanent and eſſential benefit: if under theſe circumſtances, by the change of water only, the diſeaſe begins gradually to wear away and finally diſappears, the proof is as perfect as can reaſonably be required. Much confirmation will be given to the opinion, if ſeveral, who have equally uſed the ſuſpected water, have had their health impaired; though, on the other hand, the eſcape of ſome by no means warrants us to infer that, with regard to others, our ſuſpicions are groundleſs.

The appearances I have obſerved are not at all regular and uniform in every ſubject, but on the contrary are very different in different habits. This variety is not inconſiſtent with the acknowledged laws of the ſyſtem. Beſides the common variations of age and temperament, the prediſpoſition to various diſeaſes is implanted with the firſt principles of the frame; the different organs of the body being endued with ſuſceptibilities of external or internal impreſſions, which are unequal in different bodies. All ſubſtances when received into the circulation are applied to the whole body, and perhaps not a ſingle organ is totally exempted from the action of their ſpecific powers. Each muſt therefore ſuffer in the order of its peculiar ſuſceptibility, which circumſtance is of itſelf an abundant ſource of variety in the conſequent phœnomena. If to this we add the infinite diverſity in the ſympathies of the parts with each other, or with any particular organ, we can feel no ſurprize at the numberleſs varieties and indefinite modifications which appear in the reſults.

It is neceſſary to obſerve, that much relief can rarely be expected immediately or very ſoon after the diſcontinuance of the water. The diſeaſes engendered by lead ſeem to be in their nature lingering and chronical. In caſes where preparations of this metal have been given as a medicine, and its uſe continued but a very ſhort time, it has been known to occaſion a diſeaſe of ſuch obſtinacy, as to require a very conſiderable length of time for its removal. Thus we are informed that four grains of ceruſſa acetata, taken for no longer a time than three ſucceſſive days, "occaſioned intolerable uneaſineſs in the bowels for ſome months."* It is a commonly received opinion, founded, I believe, on actual obſervation, that the longer the force of this poiſon has been accumulating before producing evident diſeaſe, the more dangerous has been the diſeaſe when produced, and the longer has been the time required for its effects to wear off. This is known to be the law obſerved, when it has occaſioned ſaturnine colic, and in this inſtance we may ſafely confide in analogical reaſoning, though the ſymptoms be anomalous. As in diſeaſe from poiſoned waters, the evident miſchief is much more ſlow and gradual than in all others, that have been hitherto noticed, the ſame law may be expected to hold good in a ſtill higher degree. Accordingly in the inſtances which have occurred to myſelf, the reſtoration to health has been very gradual: three or four months have been required, before a conſiderable amendment has taken place; a twelvemonth or more, before the complete re-eſtabliſhment of the health.

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* Medical Tranſactions. vol. 1. p. 302.

Though the cauſe of diſeaſe have been juſtly aſſigned, it will be in vain to hope that, in every caſe, health can be reſtored to its former integrity, by diſcontinuing the uſe of the water. This, it is evident, muſt depend on the nature of the diſeaſe, the ſtrength of the conſtitution, the degree of exhauſtion ſuffered by the vital powers, and various other circumſtances, which may be peculiar to each individual patient. The recovery from the ordinary chronic ſaturnine colic, when it has been of long duration, and the ſtrength has been greatly impaired, is commonly very imperfect; and the ſufferer is too often doomed to ſpend the remainder of his days in a hopeleſs ſtate of valetudinarian infirmity. When the exhauſtion of the powers of life, from the cauſe we are now conſidering, has been carried an equal degree, there can be no grounds for expecting a more favourable termination. I muſt acknowledge, however, that ſome of the caſes, which have occurred to myſelf, bore ſo unfavourable an aſpect, as to occaſion no ſmall anxiety for their iſſue. The ſymptoms, perhaps, were purely ſaturnine, unmixed with conſtitutional diſeaſes or organic alterations of the viſcera. Had ſuch affections been ſuperadded, recovery would moſt probably have been impoſſible.

One aſſertion I may venture to make from repeated obſervation, and I dare ſay it will be found univerſally true. It is that the poiſon has a much more evident and more ſudden effect upon thoſe who have been once ſtrongly affected by it, than upon others. The conſtitution ſo far from becoming reconciled to it by habit, is rendered more and more ſenſible to its irritation. This fact I ſuppoſe it is intended to expreſs, when perſons ſay, as they frequently do, that the effects of lead gradually *accumulate* in the ſyſtem. I have ſeen a delicate female, who had returned home from ſea-bathing after illneſs with a freſh complexion, and every external mark of firmer health than ſhe had enjoyed for years, loſe her colour and contract the appearance of languor and ill health in a fortnight or three weeks. Three or four years would not have effected the ſame change on the appearance, previous to the conſtitution having undergone the ſaturnine irritation. Nay, leſs than a week has been ſufficient to make repeatedly a ſenſible change in the complexion, in a young lady who made no complaints about her health, and in a ſituation where no other reaſon could be aſſigned for the alteration, than the taint, which all the water uſed by her had received.

It is on this account eſſentially neceſſary, that theſe patients be inſtructed to be moſt minutely attentive to avoid in their diet all articles, which may be ſuſpected to have by any means contracted a ſimilar taint. Their food and their liquor ſhould be free from the ſuſpicion of impurity. All ſweet wines not made at home,—ſweet cyder,—meat ſalted in leaden troughs,—milk kept in leaden veſſels,—all ſuch things, the uſe of which is ſufficiently hazardous to the ſound, may be of ſerious detriment to thoſe afflicted with theſe complaints. The culinary veſſels ſhould be examined; in ſhort, a ſcrupulouſneſs, which may be almoſt ridiculous in common caſes, ſhould be here ſeriouſly enjoined. It has been directed very properly in affections ſeemingly ſaturnine, but in which the ſource of the poiſon has eluded detection, that the patient ſhould take a journey, to Bath for inſtance ; with the intention, both, that the health may be improved, and the introduction of new poiſon be prevented by a total change in the daily habits of life. But the patients, whoſe caſe I am now conſidering, ſhould rather be adviſed to remain at home, that the miſchief, which they have there been taught to avoid, may not be inadvertently encountered abroad.

It is not enough that the pump or pipes be removed: it is moreover neceſſary to clean out the well thoroughly. The matter which has been corroded from the lead falls into the well, and though its quantity may not be very conſiderable, yet from the ſtate of diviſion to which it has been reduced, it ſtill communicates pernicious qualities to the water. This I have learned from experience, though I have not yet had an opportunity to form correct notions of the action of this matter by ſynthetic experiments. Of courſe, the ſource of this taint will become exhauſted in time; but as the quantity diſſolved at once is ſo very minute, it may be readily ſuppoſed, that, without this precaution, it may continue even for years.

This circumſtance, of the ſyſtem being rendered by habit more ſenſible of the ſaturnine irritation, may ſerve to explain how it happens, that perſons who have ſuffered the lead colic, are ſo liable to frequent relapſes of their complaint, for a long time after they have appeared to be no longer expoſed to the poiſon. One patient, out of a very numerous family of domeſtics, who had been afflicted with the colic of Poitou from the uſe of an adulterated white wine, is ſaid by Warren to have relapſed five years after the accident, to have ſuffered nine returns of the colic afterwards, and, at the diſtance of ſixteen years, to be in the chronical ſtate of the diſeaſe, with the fingers of both hands paralytic.* In this very unhappy caſe, ſomething may certainly be allowed to the power of habit, the influence of which both over the continuation and the recurrence of diſeaſes is very great: but I cannot help ſuppoſing, that the patient muſt have been expoſed to the repeated action of the poiſon. It may be, that the freſh portions, which were introduced, were ſo minute, as to have had no ſenſible operation on ſound conſtitutions, and therefore wholly eluded obſervation. This ſuppoſition is certainly the moſt conſolatory to the afflicted, as it affords them the proſpect of ſome alleviation to their ſufferings, for the encouragement and reward of a continued vigilance on their parts. It is not at all impoſſible, that this increaſed ſuſceptibility of the ſaturnine irritation may continue during the whole remaining part of life.

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* Medical Tranſactions, vol. 2, p. 89.

So far have I ſpoken of the direct and immediate influence of the poiſon on the frame: but it is highly probable that, by confining ourſelves to this point of view, we ſhall ſtill entertain too narrow and partial conceptions of the ſubject. Nothing in the animal ſyſtem operates alone; but various agents are perpetually exerting ſimultaneous forces, which either conſpire with or counteract their reſpective tendencies. Without pretending to offer any very minute or refined theory of the mode in which this mineral acts, it will be readily allowed to be a new *force* * introduced into the body, directly and in a very high degree debilitating every function, where we can trace its operation. Independent then of any ſpecific powers it poſſeſſes, it cannot be doubted, that it muſt concur and conſpire with all the other direct cauſes of debility, that it will heighten their powers, and aggravate their effects. The reſult of ſuch a concurrence of different cauſes muſt neceſſarily be complicated: hence there will be a great difficulty, if not an utter impoſſibility of diſtinguiſhing how much ought to be attributed to one of the agents, and how much to the others. Such influences they are, which call into life the innate germs of diſeaſes, that are latent in moſt bodies, and which might perhaps have ſo continued, but for the operation of foreign and accidental cir-

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* I beg leave to ſubmit to medical theoriſts the propriety of uſing this word, or ſome one equivalent to it, inſtead of the

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much uſed and greatly abuſed term *ſtimulus*. It is at leaſt unambiguous, and, in caſe of its reception, the word ſtimulus may be again reſtored to its juſt ſignification, *viz.* a ſubſtance which directly and ſenſibly increaſes animal action.

cumſtances. It ſeems then not unlikely, that a very numerous tribe of diſeaſes, which are acknowledged to be the offspring of debilitating forces, may have frequently been excited by this concealed and inſidious miſchief. Such are *ſcrofula, phthiſis pulmonalis*, dropſy, chronic rheumatiſm, *dyſpepſia* and bilious complaints, *hypochondriaſis*, and the hoſt of nervous complaints, which infeſt modern life. The poiſon itſelf would be ſtill more effectually concealed, than where it has produced its ſpecific effects, by putting on the maſk of well known forms and aſſuming familiar names. I confeſs myſelf to be unprovided with facts ſufficient to ſupport and eſtabliſh this hypotheſis on a ſolid baſis. The marked circumſtance at the concluſion of Caſe VIII is, however, much in its favour: and I hope that the facts recorded in Caſe X may not be undeſerving attention. It certainly ſeems ſufficiently conformable to the operation of other ſubſtances to merit a particular enquiry, and to be confirmed or refuted by future experience.

But notwithſtanding the effects of theſe waters is in many caſes ſufficiently palpable, it muſt be acknowledged, that the great majority of perſons, who uſe them, receive no immediate or ſenſible injury. Indeed it cannot be conceived poſſible, that the cuſtom of employing lead, for the purpoſe of containing or conveying water, could have ever prevailed in any great degree, if a conſiderable proportion of thoſe who drank the water had been found to have their health impaired within the courſe of a few years. Such an effect would have been too groſs to eſcape the obſervation of the multitude. This ſeeming general ſecurity has rendered mankind blind to the injury ſuffered by individuals, and, I doubt not, will make them ſlow and difficult in admitting the doctrine, which it is my object to eſtabliſh.

The main cauſe of this apparent ſalubrity can be no other than the very minute quantities of the metal, which are commonly taken up by the water. Different ſprings have unequal ſolvent powers; and probably thoſe, which are moſt corroſive, are likewiſe the moſt powerful ſolvents. Much too, it is evident, muſt depend on the time that the metal is kept in contact with the water, and the quantity of ſurface which is expoſed to its action. Very ſhallow wells, the water of which is much uſed, muſt, other circumſtances being equal, be the leaſt noxious. Long pipes, cloſed at one extremity, are the worſt of all. Ciſterns are double dangerous: if their uſe be continued, let them at leaſt be covered, to exclude leaves, dead flies and other accidental impurities. The water which is turbid, (there are ſome, which acquire a milky whitenefs) muſt be more than common noxious: the matter which occaſions the cloudineſs ſeems to be the ſame as that which incruſts the metal, formed under our eye. Thoſe pumps or pipes which frequently want repairs cannot but be very unwholeſome. Pipes through which there is a conſtant current are the leaſt ſuſpicious of all. But the water which paſſes even through theſe, when they are of a very great length, with curvatures in them, and a difference of elevation in their courſe, betrays ſigns of a metallic impregnation.

However minute may be the quantity of noxious matter taken up by moſt waters, I am perſuaded, that in moſt caſes it is enough to have a ſenſible influence on tender and delicate habits. As far as I can conjecture by the appearance with precipitants, there are very few waters more pure in themſelves, than thoſe of the *Priory Pools*, which ſupply the water works of the town of Warwick, and few which are leſs tainted by paſſing through the leaden pipes. The diſtance from the town is not a quarter of a mile, and many of the pipes are ſtill of wood. I cannot attribute any ſerious illneſs to the uſe of theſe waters alone; though I muſt confeſs that, my attention, till within this laſt year and half, not having been directed to this point, many facts illuſtrative of the queſtion may have eſcaped me. But in one family, which has now uſed no other than theſe waters for four years, three young ladies may be ſuſpected to have received injury from them. One has, during the laſt two years, become much thinner and has frequently ſlight pains of the bowels: all have loſt their colour and the healthineſs of their complexion; and one has repeatedly regained the freſhneſs of health, by occaſional abſence from the town. How ſoon it vaniſhes on her return home has been already mentioned. * All this would

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* See page 64, ad finem.

not be called diſeaſe, ſtrictly ſpeaking; but it would probably terminate in diſeaſe of the moſt ſerious nature, if the cauſe were neglected or miſunderſtood.

The great minuteneſs of the doſe is in part compenſated by the very abundant uſe, which is made of the vehicle of the poiſon. Beſides drinking it pure, we uſe it hourly in our tea and our coffee, in our beer and our domeſtic wines. It enters into our bread and many of the preparations uſed at our tables. It were idle to enumerate all the ways in which we are conſtantly receiving it. When we employ water in our kitchens for boiling our food, a portion adheres to and is probably abſorbed by the meat, and by the vegetables in abundance.

The ſecurity of the majority amounts to no more than a preſumption in the favour of any individual, which may or may not be confirmed by his own experience. Independent of the morbid ſuſceptibility of impreſſions, which diſtinguiſhes weak habits, there is much variety in the original conſtitution of the human frame, which occaſions a correſponding variety in the effect of equal forces. This appears with much ſtrength in the very different quantities of this metal, which different perſons ſuſtain without apparent injury. Even the majority of thoſe perſons, who have had the misfortune to uſe wine adulterated with litharge, ſo ſtrongly as to occaſion the death of ſome, appear to have eſcaped with little injury. The teſtimony of Zeller eſtabliſhes this remarkable fact. 'Many,' he informs us, 'nay, multitudes eſcaped uninjured, 'though they uſed the liquor even to intox'ication;—others were but ſlightly affect'ed.* Thoſe then who uſe theſe waters, becauſe the bulk of mankind perceive no immediate ill effect from them, are making an experiment upon their own perſons, of which they may find reaſon to repent when it is too late. The caſe of each individual muſt in truth be eſteemed ſingular and peculiar to himſelf: confiding to the experience of others is a ground of ſecurity which may prove wholly fallacious: the danger can be with certainty obviated, only by avoiding its ſource.

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* Medical Tranſactions. vol. 1. p. 240.

Hardly leſs fallacious is a confidence in a preſumed and pretended experience of our own. For firſt, as the powers of lead gradually and imperceptibly accumulate in the ſyſtem, the ſolution, which was formerly innocent in appearance, may finally ceaſe to be ſo; and it is not likely that the change can be juſtly eſtimated, but by thoſe who are thoroughly informed of the nature of this poiſon. Secondly, the original powers of the ſyſtem are, from cauſes both internal and external, in a ſtate of perpetual fluctuation. Hence it is that a force, the energy of which is at one time imperceptibly minute, may at another produce an obvious and palpable impreſſion. In infancy, in youth, and again in the decline of life, the powers of reſiſting morbific forces are more weak and imperfect: during the vigor of middle life the powers of conſervation have reached their higheſt ſtrength and perfection. Under theſe various and complicated changes of the frame, it is neither impoſſible nor improbable that the ſubſtances, which have been uſed for a ſeries of years with apparent impunity, may, notwithſtanding be eventually the occaſion of diſeaſe and of death.

If the purity of water is of conſequence to every perſon, much more ſo is it to the ſick and the valetudinarian. Beſides the debility which expoſes them, more than others, to the influence of minute irritations, they are commonly obliged to make uſe of liquids in much greater quantities than perſons in health. Thirſt is a concomitant of almoſt all kinds of ſerious illneſs. From the feebleneſs of the digeſtive organs, another concomitant of moſt diſeaſes, the aliment of ſuch perſons conſiſts chiefly of fluid matters. On every account then, the uſe of theſe tainted waters may be expected to be more than commonly injurious to the ſick and the valetudinarian, and frequently to preſent a powerful obſtacle to the reſtoration of health. The prejudices, which will naturally influence the patient, and perhaps the medical attendants, will ſerve to increaſe the hazard. For, having uſed the ſame water when in health, perhaps with little or no ſenſible detriment, they will be ſlow in apprehending and difficult in admitting that to be now pernicious, which a fancied experience had made them formerly believe to be perfectly innoxious. The attributing too, and, it may be, rightly, the origin of their illneſs to other cauſes, will be apt to confirm them ſtill more in their error, and to divert their attention from a main cauſe of the continuance of their valetudinary condition.

I know not whether the peculiar ſtate of combination in which the lead is found in all ſpring water partially, and in many particular waters completely, and which I have ſuppoſed to defend the *primæ viæ* from its immediate action, may alſo render it leſs powerfully noxious on the other parts of the animal ſyſtem. This, to be admitted requires to be eſtabliſhed by ſtrong evidence: and as long as that is deficient, it is ſurely the part of prudence, that our ignorance ſhould be enliſted in our defence and employed on the ſide of our ſecurity. The preſumption itſelf affords but very feeble grounds of ſafety, ſince I have found water drawn from the ſame ſpring contain the metal under different forms of combination, when examined at ſeparate times.

The variety of appearances preſented by the waters of the ſame place ſuggeſts the propriety of a further caution againſt being deceived by falſe analogies. It is that there is great hazard in preſuming on ſuch grounds, that becauſe in any particular town or diſtrict leaden pumps have been commonly uſed without any perceptible detriment, there are not particular ſprings in the ſame diſtrict where the practice would be very pernicious. Scarcely any two waters have exactly the ſame qualities, and they are often found to be extremely different at an interval of no more than a few yards.

The queſtion of the greateſt magnitude

as it regards ſociety in general, ſince it regards the health of a great multitude of its members, remains ſtill to be treated. It is to enquire what is the effect of theſe waters on the great body of thoſe who uſe them. Are they really inert upon that immenſe number of perſons who are conſuming them daily with apparent impunity? Is it a true or an apparent ſalubrity only, which they poſſeſs?

If theſe ſolutions have no other ill effect than promoting a coſtive habit of body, (an effect of which, I ſuppoſe, moſt perſons will allow them capable) this is of itſelf an evil of no ſmall magnitude. This habit is alone a great and conſtant inconvenience; it forms obſtructions which give riſe to dangerous and often fatal inflammations; many of the moſt ſevere diſeaſes, which afflict our frame, are its offspring, either immediately or indirectly, and all diſeaſes whatever, whether acute or chronical, are from this circumſtance frequently rendered obſtinate and intractable, as from its removal they frequently become mild, and yield to the efficacy of medicine, or even to the conſervative powers inherent in the ſyſtem.

The celebrated Darwin, living in Derbyſhire, where lead mines are ſo abundant, had a ſuſpicion, that minute portions of the mineral were the exciting cauſe of the Bronchocele, ſo common in Alpine countries. He communicated and ſupported this opinion in a correſpondence he entertained on this ſubject with Mr. Wilmer; and I regret much, with the latter gentleman, that his letters are not now in exiſtence. In the Zoonomia * he ſeems inclined to aſcribe the diſeaſe generally to the uſe of the water of the Derwent, ſupplied

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* Darwin's Zoonomia, vol. 2. p. 114.

from the mountainous part of the country, but without making a particular ſpecification of the matter which he would conſider as noxious.

In Coventry too this diſeaſe is thought to be more than commonly frequent, and Mr. Wilmer thinks that thoſe, who uſe the water of the Swanſwell pools, are the moſt afflicted with it. Both the waters of the Derwent at Derby and the Swanſwell water at Coventry paſs through leaden pipes, and each take up ſome of the metal in their paſſage. I could not detect it in either of theſe waters, previous to their contact with the metal. But the Derwent water ſeemed to have metallic matter either diſſolved by or mixed with it; the quantity I had to examine was too minute to enable me to determine its particular nature.

Without pronouncing on this hypotheſis, which at leaſt merits notice from the deſerved celebrity of its propoſer, I return to the weighty queſtion laſt propoſed—viz: What is the effect of theſe tainted waters on the health of that great multitude of perſons who habitually employ them? Some are ſo ſtrongly charged with the metal as to prove real poiſons in the courſe of a few years: many ſhow the ſpecific effects of the lead; and I think I have rendered it probable, that all have a ſenſible effect on weak and irritable conſtitutions, or thoſe which are peculiarly ſuſceptible of the ſaturnine irritation. Can they then be reaſonably thought wholly innoxious upon any? Is it not infinitely more probable that all muſt feel in a greater or leſs degree their influence, in debilitating the frame, exhauſting the vital energies, exaſperating diſeaſes, accelerating the advances of old age, and finally in ſhortening that period, which would otherwiſe be allotted to human life?

I may be told perhaps of perſons who, under theſe circumſtances, have enjoyed a ſeries of good health, and have arrived at old age without the ſuſpicion of injury. But may not the ſame be ſaid of many who indulge in pernicious habits of all kinds? It is notorious, that there are perſons addicting themſelves to the intemperate uſe of ſpirituous liquors, who attain to a vigorous old age, in ſpite of the irregularity of their habits. But even in this caſe it is likely that the ſot, who dies at ſeventy, would have reached fourſcore, had he not been prevented by his vices. It is impoſſible to determine preciſely the period of old age. But if a man, having arrived at his climaterick, begins to decay, and after a few years or a few months of bad health ſinks into the grave, all the world preſumes, without any further enquiry, that ſuch a death is no more than yielding to the inevitable neceſſity of our nature.

To eſtabliſh beyond contradiction the reality of the evil, and to form ſome conjectures or calculation of its magnitude, requires an extenſive reſearch. Bills of mortality are the proper baſis of ſuch an inveſtigation; and if they can be made to furniſh unexceptionable data for the purpoſe, very important indeed may be the advantages derived to ſociety from them. In what manner the enquiry ſhould be purſued is ſo obvious, that it is needleſs for me to enter into any details on the ſubject. The only difficulty is to determine the ſituations, which may ſupply the neceſſary materials for ſuch a calculation. But, I doubt not, many ſuch may be diſcovered in various parts of the kingdom. Even the records of private families, as to the number of children which have been reared, and other obvious enquiries, may in ſome circumſtances furniſh us with uſeful and ſatisfactory reſults. But this labour I leave to the zeal and induſtry of thoſe, who may become ſenſible of the utility of ſuch an undertaking.

The metropolis of the kingdom is, I apprehend, as much, if not more intereſted in the object of this enquiry, than any other town in Europe. The Thames and New River are the principal ſources from which this great city is ſupplied with water. Neither of theſe waters are conducted through lead, except for a ſhort diſtance through the ſmall collateral branches, which convey it from the main pipes to the ſeparate houſes. In theſe the fluid ſtagnates and I have found that ſmall quantities of metallic matter are diſſolved. There are other water-works for the convenience of particular parts of the town, but of what materials the pipes are formed I have not as yet learned.

Theſe pipes cannot be entirely harmleſs, though they convey the water through ſuch ſhort diſtances. But the ciſterns with which, I am told, almoſt every houſe is furniſhed, and alſo the apparatus for conveying it to ſeparate apartments, which are very common in the better kind of houſes, are what I ſuſpect to be productive of infinitely greater miſchief. Theſe, I ſuppoſe, have been gradually extending and increaſing in number, and the uſe of common pumps diminiſhing in the ſame proportion. Beſides the ſcanty ſupply from pumps in ſo populous a place, and particularly in dry ſeaſons, to keep them in repair and renew them when decayed is attended with much expenſe, and with ſtill greater trouble and inconvenience. On this account, it may be expected that, where water can be procured by other means, common pumps will be gradually neglected, and fall into diſuſe. I aſk then whether, through the whole of the laſt century, the uſe of the Thames, and particularly of the New River water, has not been increaſing; and in conſequence whether there are not at preſent a greater number of ciſterns, and fewer common pumps in the ſame proportion, then there were a hundred years ago?

It appears that certain diſeaſes have been increaſing in London through the laſt century, which, there is reaſon to think, would have diminiſhed, if no new exciting cauſe had been introduced. The number of deaths claſſed under conſumption, which in the beginning of the laſt century amounted annually to 3000, on an average of ten years, in the middle of the century amounted to 4000, and in the end to 5000. To obtain this average, thoſe years were ſelected in which the whole number of deaths were nearly equal.* Now it muſt be acknowledged that the moſt powerful exciting cauſe of this claſs of diſeaſes, (for the meaning of the term muſt not be confined to the *phthiſis pulmonalis)* in populous and profligate towns, is ſyphilitic diſorders and their conſequences. If theſe diſorders have not been leſs frequent, ſtill the treatment of them has been made much leſs ſevere than formerly, and the conſtitutions of great numbers are now preſerved, which would have ſeverely ſuffered under the harſh method of cure, that was formerly univerſally practiſed.

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* Obſervations on the Increaſe and Decreaſe of different Diſeaſes—by Wm. Heberden, jun. M. D. p. 42.

The great exciting cauſe of dropſy is the intemperate uſe of fermented liquors, and particularly of pure vinous ſpirits. All of the better claſs have within the laſt half century become more refined in their manners, and more ſober in their habits, and it can hardly be doubted that this improvement has ſpread in ſome degree through every rank of life. We ſhould expect then dropſies to have been diminiſhing in number. But we find on examination, that in the beginning of the laſt century they were much on the increaſe, and in the end they were ſtationary. The numbers were in the beginning 850, in the middle 900, in the end 900. Palſy and Apoplexy preſent a reſult ſimilar to conſumption. The numbers were in the beginning of the century 157, in the middle 280, in the end 300.

Theſe are the claſſes of diſeaſes which I ſhould attribute to the habitual introduction of minute quantities of lead into the ſyſtem. But I beg to be underſtood as not ſpeaking with confidence on a ſubject, where I do not poſſeſs the neceſſary data to form accurate concluſions. Nor do I by any means think, that my hypotheſis is ſufficient to account for all the circumſtances. The wretched condition to which the labouring claſſes of the community have been more and more reduced, particularly during the latter part of the paſt century, muſt have had a prodigious influence on the diſeaſes of the metropolis, and have more than counterbalanced the boaſted improvements in the ſalubrity of the town.

Should the truth of theſe ſuſpicions be eſtabliſhed by proper evidence, and in particular ſhould the reality and the magnitude of the miſchief in this great city be demonſtrated by proper evidence (for the fact of its exiſtence is of greater conſequence than whether it be increaſing or diminiſhing) a caſe may be immediately made out, on which might be founded ſome legiſlative regulation. This alone preſents an effectual method of putting a ſtop to the evil. Individuals, whoſe means are abundant, will be ready enough to take care of themſelves, as ſoon as they are duly enlightened; and their knowledge and example will eventually have a beneficial influence on the cuſtoms of the community. But the diffuſion of knowledge is always ſlow, independent of the obſtructions it has to encounter from prejudice and ſelf intereſt. Who then, in the mean time, is to take care of the numerous claſs, whoſe lot in ſociety renders them callous to the preſent and indifferent to the future—of the families of the labourer, the artiſan, the little ſhopkeeper, who are enforced to occupy tenements, the property of another? The ſufferings of our ſpecies are but as a make-weight in the calculations of avarice, and hardly incline the balance on the ſide of humanity, when oppoſite intereſts are equally poiſed. We may be quite ſure that the cheapeſt modes of accommodation will in general be preferred by thoſe, who are not directly intereſted as conſumers, unleſs a degree of coercion be uſed in favor of the moſt ſalubrious.

It may be that perſons, who become ſenſible of the bad conſequences of the practice I have attempted to guard them againſt, have it not in their power to procure water under any other circumſtances. To ſuch it will be a ſatisfaction to know, that there are ready methods of obtaining it pure.

The moſt obvious of theſe, and, I think, that which is preferable to all others is diſtillation. Dr. Heberden has recommended diſtilled water in the Bronchocele, in ſwellings of the lymphatic glands, and in many chronical pains of the ſtomach and bowels. ‘In theſe caſes,’ he ſays, ‘a courſe of diſtilled water might be as beneficial as the moſt celebrated mineral waters are in any other diſorders, and might prove no inconſiderable addition to the Materia Medica.’* The approved method of conducting this ſimple proceſs is, that if the ſtill holds twenty gallons (which is the moſt convenient ſize where large quantities are deſired) the firſt gallon ſhould be thrown away, as it has always a diſagreeable muſty taſte. The remainder has at firſt an unpleaſant empyreumatic or burnt taſte; this will go off by keeping, in about a month. It may be deſtroyed by ventilation in the mode deſcribed by Dr. Hales; or more readily ſtill by boiling it in an open veſſel. If this water be kept in perfectly clean glaſs or ſtone veſſels, with glaſs ſtopples or metal covers, it is incapable of being ſpoiled, and will therefore keep for ever. Though the worm of the ſtill be of lead, it is probably of no conſequence, if the firſt portion of the water be thrown away. I ſhould prefer, however, a worm made of other materials.

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* Medical Tranſactions, vol. 1. p. 21.

A ſecond method is by the uſe of quicklime. Let the water be boiled in an iron boiler with a few handsful of freſh lime, and let it be likewiſe kept in contact with the lime three or four days. The lime will gradually precipitate all the metallic matter. I have not found twenty four hours ſufficient to purify the water, but after two days I have been no longer able to detect any veſtiges of lead. It will, of courſe, be better to exceed this time than to fall ſhort of it. After the proceſs, it is farther neceſſary to get rid of the lime, which can be effected, only by combining it with carbonic acid. Mere expoſure to the atmoſphere in broad ſhallow veſſels will ſuffice, only taking care to break the cruſt, which forms upon the fluid. Two methods have been thought of for doing this with more expedition. The one, invented by Dr. Alſton, is by throwing into water a quantity of magneſia. This imparts a portion of carbonic acid to the lime, which, thus becoming inſoluble, falls to the bottom, and leaves the water pure. Another method is that propoſed by Mr. Henry; he has invented an apparatus for precipitating the lime by means of an efferveſcing mixture of chalk with any of the powerful acids.* A ſtrong phial, furniſhed with a valve at its orifice, and plunged to the bottom of the veſſel, is apparatus enough. The water will, by theſe proceſſes, be made purer than at firſt, ſince, beſides the lead, it will have parted with all the chalk it may have previouſly contained.

Theſe waters cannot be harmleſs, although uſed only for boiling; ſince, as I have before obſerved both meat and vegetables abſorb ſome part of the fluid, in which they are immerſed. If we apply ſteam, the danger from this quarter will be effectually guarded againſt.

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* Encyclopædia Britannica; Article, *Putrid Water.*

It may be thought by ſome, that I have given myſelf much uſeleſs labour, in adducing arguments, to evince the unwholeſomeneſs of waters that contain lead in ſolution, however minute the quantity; and, indeed, I believe moſt enlightened perſons will require little farther evidence on the ſubject, than that the main fact be firmly and correctly eſtabliſhed. But the bulk of mankind will hardly be contented with this kind of proof; and will be apt to imagine it impoſſible, that ſuch a maſs of evil, as I have repreſented, ſhould have remained to this time concealed from common obſervation. With thoſe, who are aware of the difficulty of tracing effects to their true cauſes, this objection will have very little weight. The buſineſs of juſtly connecting cauſe and effect, though a mental operation of which the weakeſt perſons are apt to conceive themſelves capable, is one, which demands the moſt laborious and the moſt diſpaſſionate attention. When the effect is the immediate offspring of the cauſe alleged, if the opinion, it is wiſhed to eſtabliſh, counteract the prejudices and the practices of the world, it will ſeldom be admitted, without encountering cavil and contradiction. But here numerous obſtacles have concurred to conceal and diſguiſe the miſchief, even from the eyes of the moſt penetrating. The principal of theſe I have already touched upon in the courſe of this enquiry; they are, the very great ſlowneſs with which diſeaſe from this ſource is excited; the obſcurity of the ſymptoms, and their reſemblance to the ſigns of other diſeaſes; and, finally, the multitudes who eſcape without apparent injury. Theſe reaſons I deem quite ſufficient to explain, why ſo little apprehenſion has been hitherto excited, by the perpetual uſe and application of one of the moſt noxious minerals.

We are every day hearing a change of air recommended to invalids, and the benefits of this change form a never-ceaſing theme of panegyrick. I do not preſume ſo far to contradict popular opinion, as to aſſert, that this notion is commonly deſtitute of foundation. But I may venture to remark, that little trouble is taken to inquire whether, in particular inſtances, the advantage of the change be not derived from very different cauſes. Eudiometrical obſervations have hitherto failed to diſcover any material differences in the air of different ſituations and climates; and I cannot but ſuſpect that, where the air has been expoſed to no obvious ſource of pollution, the benefit, which is attributed to the change of air, ought frequently to be aſcribed to the change of water. Does it ſeem conſiſtent with the acknowledged care of providence for the conſervation of its works, to ſuffer poiſons to be generated in that atmoſphere, in which it has deſtined the human race to exiſt, and over which the feebleneſs of mankind can have no poſſible influence? When man was ordained in the beginning to 'ſub-' due the earth,' a taſk was ſurely impoſed on him, with which his powers were commenſurate. He has in part fulfilled his deſtiny; and he bids fair one day to poſſeſs a complete controul over the ſubſtances, which affect his organiſation. As Franklin finely expreſſed himſelf, 'Mind will become om-' nipotent over matter.' Even at preſent his well-being is very much in his own hands, and greatly depends on the uſe or abuſe of the materials, he appropriates to his ſervice. His ignorance it is, which forms the main obſtacle to his progreſs towards perfection and happineſs. Perhaps a more ſtriking example cannot be adduced of this poſition, than the object of this enquiry. It is indeed an almoſt incredible inſtance of perverſe induſtry and miſ-directed power, that the element, which is preſented to him by nature pure and ſalubrious, ſhould be converted, by his own hands, into an inſtrument of his deſtruction.

Caſes and Obſervations.

CASE I.

THE firſt caſe I ſhall offer has been before the public many years, and though the reaſoning uſed by the writer is by no means ſatisfactory, the facts are ſo important, that I think it is uſeful to republiſh them. The relation is given by Dr. Wall, in the ſecond volume of the medical Tranſactions, page 420.

'A gentleman of this town (Worceſter) 'was the father of a numerous offspring, 'having had one and twenty children, of 'whom eight died young, and thirteen ſur'vived their parents. During their infan'cy, and indeed until they had quitted their 'uſual reſidence, they were all remarkably 'unhealthy; being particularly ſubject to

‘ diſorders of the ſtomach and bowels. The ‘ father during many years was paralytic; ‘ the mother for as long a time ſubject ‘ to colics and bilious obſtructions. She ‘ died at laſt of an obſtinate jaundice.— ‘ After the death of the parents, the family ‘ ſold the houſe, which they had ſo long ‘ inhabited. The purchaſer found it neceſ‘ſary to repair the pump. This was made ‘ of lead; which upon examination was ‘ found to be ſo corroded, that ſeveral per‘forations were obſerved in the cylinder, ‘ in which the bucket plays, and the ciſtern ‘ in the upper part was reduced to the thin‘neſs of common brown paper, and was ‘ full of holes like a ſieve.’ He concludes the caſe with obſerving, in conformity with the experiments and deductions of Sir G. Baker, that, though water may not be a true ſolvent, ‘ ſo much lead may be mechanical‘ly mixed and ſuſpended in water, as to ‘ communicate to it noxious qualities.’

I have already ſufficiently noticed, how inadequate this hypotheſis of mechanical mixture and ſuſpenſion is to the explication of the effects aſſigned. The pump water of Worceſter diſſolves lead, like all others that I have examined; and all pumps will be found to be, in the end, reduced to the ſame condition, as that deſcribed by Dr. Wall. The caſe, however, is very valuable, as well from the facts related, as from the authority of the writer.

* CASE II.

Many years ago, an old man of the name of Moore, in the town of Warwick, had one of theſe pumps taken up, which he had himſelf put down, from perceiving that both his own health, and that of his wiſe and female ſervant had been injured by it. He had pains of the bowels and a paralytic tremor: of the nature of the complaints of the two others I am uninformed. Though I have found this ſtory in the mouths of ſeveral perſons, it has produced no effect on the practice of the inhabitants of the place; nay, I have much reaſon to think, that a gentleman, who was directly inſtrumental in having this pump removed, from a dread of uſing the water, which ſupplied his own houſe likewiſe, afterwards became a victim to the very ſame miſchief, in a new ſituation. He uſed for ſome years the water, which I have ſuppoſed to injure the ladies, whoſe caſe I have mentioned in page 75. He was affected with uneaſineſs in the bowels for a long time, and this ended in a total conſtipation. I did not viſit him, but I know that the ſymptoms were ſuch, as to puzzle very much the phyſician, who attended him, a gentleman of great experience and acknowledged ſagacity. The body was examined after death, but the diſſection diſcovered nothing, which could ſerve to explain the ſymptoms of the diſeaſe. It was pronounced to be a *palſy of the inteſtines*, a mode of expreſſion which I believe to have been quite correct, though I confeſs it ſeemed to me not very intelligible, at the time it was uſed.

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* I had this caſe repreſented to me as an inſtance of palſy, from the water of a lead pump, and as ſuch I have cited it in page 33; but, upon a more accurate inveſtigation, I do not feel juſtified in any further repreſentation of it, than what I have given above.

CASE III.

The following caſe is the firſt in which I detected the noxious qualities of waters tainted by lead, and has been the occaſion of the preſent inveſtigation.

A married lady, of a thin and delicate habit, had been ſubject all her life to dyſpeptic complaints, the conſequence of a weak digeſtion and irregular periſtaltic action. But, for three or four years, theſe complaints had been much aggravated, with the acceſſion of new ſymptoms. The principal of theſe were, ſpaſmodic pains of the ſtomach, flatulence, hard and tumid abdomen, and very irregular action of the inteſtines. She had alſo occaſional palpitation of the heart, and was on the whole much haraſſed and a good deal worn by her complaints. Among other things, ſhe remarked that ſhe was always worſe at home, and this point became ſo ſtrongly marked, that, at length, the pain of the ſtomach came on almoſt inſtantaneouſly on returning from occaſional abſences, though ſhe had not felt it before for a length of time. In the ſummer of 1801, I was informed that the water uſed in the family was conveyed through lead; and at my ſuggeſtion the pipes and pump were changed for wood. She was abſent that ſummer at the ſea, and her complaints were greatly better. She ſpent the following winter at home, ſtill troubled with her old complaints, though upon the whole they were leſs ſevere. So alſo paſſed the ſpring and ſummer of 1802. The autumn was again ſpent at the ſea, and all the ſymptoms vaniſhed, except occaſional recurrence of the hardneſs and uneaſineſs of the bowels. On her return home, after ſome days the pain of the ſtomach again recurred, of which ſhe had felt nothing for the three preceding months. I now examined the water, and was much ſurprized to find a minute impregnation of lead in it. I ordered the well to be thoroughly cleaned, and in this proceſs they found ſome pieces of ſolder in the water, which had fallen into the well, when the pipes had been formerly put down. Since theſe have been removed, the pain of the ſtomach has not once recurred.

During the laſt three years, this lady has uſed water, not kept in contact with lead, three times for a continuance; once during a reſidence at Malvern, and twice when at the ſea: At each of theſe periods ſhe was free from the pains of the ſtomach, which as conſtantly recurred with the uſe of the tainted waters.

CASE IV.

A gentleman of the ſame family, who is more advanced in life, was affected in a more alarming degree. He had been afflicted for a ſeries of years with a feeble digeſtion, and the train of ſymptoms that commonly paſs under the name of atonic gout. For the laſt four or five years, theſe complaints had been exceedingly aggravated. Oppreſſive flatulence, *borborygmi*, irregular inteſtinal action, diſturbed ſleep, conſiderable emaciation and loſs of ſtrength formed a train of ſymptoms ſufficiently alarming. To theſe were added pains in the bowels, becoming more conſtant and ſevere, though they were never of exceſſive violence. The pain came on in paroxyſms, was frequently excited by motion, fatigue, and other occaſional cauſes. A tingling numbneſs of one arm ſucceeded to theſe complaints, which was regularly felt every night. Medicines which regulated the inteſtinal evacuation gave conſiderable relief; Bath water too was of temporary advantage. Nothing elſe that was adminiſtred was of any ſervice; and though there were many intervals in which the ſymptoms were leſs ſevere, upon the whole the diſeaſe ſeemed to make daily progreſs, the ſtrength to diminiſh, and the proſpect of the event was extremely diſcouraging.

For three or four months after the removal of the pipes &c. no material amendment took place, except that medicines ſeemed to have a better operation; but during the whole of the preſent year, (1802) the general health has improved ſo greatly as to diſſipate all anxiety for his ſafety. The numbneſs of the arm is hardly felt, the the pains of the bowels are trifling; the emaciation has diſappeared, the ſtrength is re-eſtabliſhed.

Had the water been made thoroughly pure, when the pipes were removed, I think it fair to preſume, that thoſe ſymptoms, which I regard as purely ſaturnine, viz. the numbneſs, emaciation and pains of the bowels, would have entirely vaniſhed before this time. As it is, the great improvement in the health can be aſſigned to no other cauſe than the ſuperior purity of the water, ſince little medicine has been taken during the whole period of amendment, and that of no other kind than what had been formerly uſed with ſo little general good effect.

A young lady, who had hitherto enjoyed excellent health, became diſordered a ſhort time before the removal of the pipes. Her complaints were confined to the abdominial viſcera, with ſlight palpitation of the heart. Her health was not thoroughly re-eſtabliſhed for near a twelve-month, when it became as firm as ever.

One tender ſubject of this family fell a victim, as I am perſuaded, to this cauſe. His diſeaſe was for a long time confined to the abdomen, but a confirmed dyſpnœa and extreme emaciation at length ſupervened, which proved fatal in the courſe of eight or ten months.

The tainted water had been uſed in this family about ſeven years. It was quite pellucid, but it depoſited a conſiderable white ſtain on its edge, when it had been kept in an open veſſel a few hours. This property it has now loſt.

CASE V.

The facts narrated in this caſe I received by the kindneſs of Dr. Heberden, jun. to whom they were communicated by Sir G. Baker. 'The moſt remarkable caſe on 'the ſubject, that now occurs to my memo'ry, is that of Lord Aſhburnam's family in 'Suſſex, to which ſpring water was ſup'plied from a conſiderable diſtance in lead'en pipes. In conſequence, his lordſhip's 'ſervants were every year tormented with 'colic, and ſome of them died paralytic. 'A phyſician of Battle, who correſponded 'with me on this ſubject, ſent up to me 'ſome gallons of that water, which were 'analyſed by Dr. Higgins, who reported 'that the water had contained more than 'the common proportion of fixed air; and 'that he found in it lead in ſolution, which 'he attributed to the fixed air. In conſe'quence of this, Lord Aſhburnam ſubſtitu'ted wooden for leaden pipes, and from

‘ that time his family have had no particu-
‘ lar complaints in their bowels.’
Richmond, September 7, 1802.

As I am unacquainted with the method by which the lead was detected by Dr. Higgins, I am unable to pronounce on the confidence, which may be placed in his analyſis. However, the hiſtory eſtabliſhes beyond controverſy the main fact of lead having been diſſolved in this water, whatever may be our opinion of the hypotheſis adopted by Dr. Higgins to explain its ſolvent power. Indeed this hypotheſis is not at all tenable, unleſs the doctor is in poſſeſſion of facts, in contradiction of thoſe which are already before the public. The celebrated Bergman took much pains to effect the ſolution of lead by aerated water. He put into phials of this water, beſides many other ſubſtances, granulated lead, minium and ceruſſe, but he could not perceive the ſmalleſt ſigns of the metal having been diſſolved by the water. He alſo expoſed to the action of this water the oxyd of lead, in a ſtate of extreme diviſion, effected by recent precipitation, but ſtill with no better ſucceſs. *

CASE VI.

Mrs. P— died in the beginning of 1801 of pulmonary conſumption, after an illneſs of twelve months. During the courſe of her illneſs, ſhe had been obſerved to become a good deal better more than once, when from home; but this circumſtance was not at the time connected with any peculiarity of her ſituation or habits. Her huſband, Mr. P— had been remarked for a long time to look pale, and to be a little ſhort breathed:—he was always greatly

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* Bergman's Phyſicial and Chemical Eſſays. Vol. 1. p. 51 and 53. London, 1784.

troubled with indigeſtion, flatulence and irregularity of the bowels; but theſe complaints were attributed principally to diſturbed nights and the anxiety of a long and moſt aſſiduous attendance.

Soon after Mrs. P—'s death, Mr. P— took a journey to Scotland, and was there ſeized with a pneumonic complaint. This was pretty well removed before his return; but he brought home, after an abſence of ſix or ſeven weeks, a troubleſome dry cough, accompanied with perpetual ſickneſs. Theſe ſymptoms too yielded to medicine, and we were flattered with the proſpect of his complete reſtoration. But he now began to be troubled with a perpetual and tormenting pain, which was referred to the ſternum, and which reſiſted every effort uſed to relieve, or even to palliate it. At the ſame period, he began to be troubled with palpitation of the heart, which attacked him irregularly, in bed as well in the day time. The appetite was impaired, the ſtomach oppreſſed with flatulence; the ſtrength diminiſhed; the fleſh waſted; he was exhauſted by night-ſweats; and the reſpiration was very much ſtraightened. Medicine was wholly ineffectual; certainly not through the defect of the preſcriber, ſince to my own zeal in his ſervice, were united the ſkill and mature judgement of Dr. Edward Johnſtone. He appeared completely hectic, though without cough. In this condition, which appeared to me almoſt hopeleſs, he removed to the weſt of England. Soon after his arrival there, he was attacked with diarrhœa, which reduced his ſtrength ſtill farther. But from this time he began ſlowly and gradually to recover. All the ſymptoms wore off, the appetite, ſtrength and reſpiration improved, and he advanced towards health with the ſame progreſs he had before receded from it. During this time of his recovery, he abſolutely took no medicine at all.

Equally pleaſed and ſurprized at a recovery to me ſo unexpected, and knowing that the whole family had been more than commonly unhealthy, I now enquired about the water. I found that the pump was of lead, which had been put down by Mr. P— and had been uſed four or five years. The water had been always very cloudy, ſince the leaden pipes had been put down; and by analyſis I diſcovered that it abounded with lead.

It is now upwards of a year and half ſince the uſe of this water has been diſcontinued. The health of Mr. P— is not merely re-eſtabliſhed, but is much firmer than it had been for a long time before his illneſs.

Two of the ſymptoms haraſſed him extremely, long after the others had diſappeared. Theſe were the palpitation of the heart, and the pain referred to the ſternum. But the firſt has now vaniſhed for ſeveral months; the ſecond is even now felt occaſionally in a ſlight degree, after conſiderable intervals of perfect eaſe. It is evident, that though it is referred to the cheſt the ſtomach is its real ſeat; for it is always ſucceeded and in appearance relieved either by an extraordinary eructation of wind, or by diarrhœa.

Had the caſe of this gentleman proved fatal (which, I am convinced, muſt have ſoon happened, had it not been for his fortunate removal from his own houſe) it would have been cited as a proof of the contagious nature of conſumption; for ſo, in vulgar language, would the diſeaſe have been called. What influence the water had on the diſeaſe of Mrs. P. it is not eaſy to ſay. It certainly accelerated the fatal event: but ſhe ſeemed to have had from her childhood a prediſpoſition to the diſorder, which occaſioned her death.

CASES VII AND VIII.

In the ſpring of the ſame year, two of the children in this family, the elder about ſeven, the younger five years old, were attacked about the ſame time with a diſorder in the reſpiration, exactly ſimilar in each. The elder happened to be removed very ſoon after to another houſe, and the diſeaſe quickly diſappeared. But it continued to affect the other ſeveral months. The reſpiration was performed with a croaking ſound, like a ſlight degree of the croup, and as if the paſſage of air through the glottis was obſtructed. At times the action of the heart appeared to be very irregular; but from ſo young a ſubject, a diſtinct account of his feelings could not be expected. The countenance was pale, and the health and ſtrength a good deal impaired. Repeated emetics were adminiſtred, and many medicines tried, but without giving any effectual relief. At length, he removed with his father to the weſt of England, where the diſorder wore off, without the aid of medicine, in no great length of time. But though he has been without complaint for more than a twelvemonth, his countenance did not acquire the appearance of health, till the cloſe of 1802.

It is very obſervable, that this child, during the courſe of the diſeaſe I have deſcribed, was alſo afflicted with *opthalmia* in each eye. The inflammation was of that indolent ſpecies, which would have been termed ſcrofulous. This reſiſted likewiſe all the uſual applications; but it diſappeared with his other complaints, and has not recurred.

CASE IX.

A ſtill younger child of the ſame family had never enjoyed good health. The belly was tenſe and tumid, the body coſtive, and the countenance pale and ſickly. He is become perfectly ſtrong, healthy, and freſh coloured.

CASE X.

I hope the following caſe will not be deemed wholly irrelevant, though, in the preſent ſtate of medical information, the aſcribing of it to the deleterious power of lead is wholly conjectural.

In the courſe of the ſummer of 1802, I attended a man, who had uſed for a great many years the water of one of theſe pumps. In this water I diſcovered lead in ſolution. He had been for two or three years in a declining ſtate of health. The countenance was ſallow, the liver tumid, the legs anaſarcous, and a fluctuation was perceptible in the abdomen. There were at times effuſions of blood under the ſkin of the lower extremities, as in the true ſcurvy. At length he voided a conſiderable quantity of blood by the rectum, and, as was to be expected, he finally ſunk under this accumulation of evils.

This man was of middle age, and had been employed for many years as a bailiff to an opulent farmer: he was ſober and temperate, and had never ſuffered the hardſhips of poverty, or of extreme labour. Perhaps it would be impoſſible to ſelect a ſituation, in which any individual would enjoy a better chance of arriving at old age, than that which was the lot of this perſon. I know not to what to attribute the extreme exhauſtion of the vital powers, under which he laboured, if not to the deleterious quality of the poiſonous matter, which had been ſo long applied.

Nearly at the time of my attending this patient, I met accidentally with two other caſes of dropſy, in houſes which were ſupplied with this kind of water. The one was a confirmed *aſcites*; the other incipient *anaſarca*. Both ſubjects were women juſt entering on the decline of life. Dropſy is a diſorder by no means common in country ſituations, or to perſons who have lived regularly. Many, who have uſed water contaminated by lead for a ſeries of years, acquire the appearance of hard drinkers, and ſeem to be ſubject to complaints reſembling thoſe, which ſpring from the unhappy practice of ſuch perſons.

CASE XI.

In the month of September, 1801, I attended a young woman ill after a miſcarriage, who had been married about a twelvemonth. Her health had been always feeble, as ſhe had been frequently afflicted with hyſterical complaints, and with diſorders of the bowels. Her preſent illneſs was of this nature. She received relief from the medicines preſcribed. As ſhe remained, however, in a valetudinary condition, I again viſited her towards the end of the year. I found her ſtill labouring under ſymptoms ſimilar to thoſe ſhe had at firſt ſuffered, except that they were leſs ſevere.

In July, 1802, I was deſired to ſee her for the third time; and I found her ſituation greatly more alarming, than I had as yet obſerved it. It was ten months from the firſt attack of illneſs, and though ſhe had often been better, her amendment had been ſo imperfect, that ſhe had not been able to quit her houſe more than once, during this whole time. Her countenance was ſallow and cadaverous; and the ſtrength was greatly impaired; ſhe had a burning heat of the ſtomach, much flatulence and indigeſtion, and the bowels were irregular; to theſe ſymptoms were added vagrant pains of the limbs, the gums ſwollen and teeth looſe, as in the ſcurvy, a pain in the cheſt between the breaſts, exceſſive perſpirations, and palpitation of the heart: the reſpiration was very ſhort, and the voice weak: in fine, a ſlow waſting fever, though without cough. All theſe ſymptoms had been coming on gradually, and were increaſing without having been preceded by any ſevere and violent illneſs. Some of them ſo much reſembled thoſe, which had been ſuffered by Mr. P—, (detailed in Caſe VI.) that I could not but ſuſpect they had a ſimilar origin. Nor was I deceived in my conjecture. The water ſhe uſed was raiſed by a leaden pump, and it contained lead in ſolution. She was forbidden to uſe it any longer. With this injunction ſhe has now complied about ſix months. Though I cannot announce her complete reſtoration, the utility of the injunction was more quickly evident, than in any caſe I had hitherto obſerved. The ſallow cadaverous countenance ſoon diſappeared, and the gums became firm. The ſymptoms, which I eſteem to be purely ſaturnine, are entirely removed. Theſe are, the pain referred to the cheſt, (the ſeat of which is the ſtomach) the heat of the ſtomach, the ſtraightneſs of the reſpiration and feebleneſs of the voice, and the palpitation of the heart. She has frequently taken exerciſe out of doors; but ſhe has often ſuffered diarrhœa with a ſwelling and pain of the bowels. Theſe attacks have thrown her back into a ſtate of weakneſs, at the moment ſhe was expecting to be completely reſtored to health.

The diſeaſe in this caſe was, at firſt, entirely independent of the bad qualities of the water; and I regard it as an inſtance of the great hazard, which valetudinarians, more than others, incur from the uſe of water ſo circumſtanced.

Her huſband has been accuſtomed to the ſame water for a long ſeries of years. But he is not a healthy man; his complexion is ſallow, and he is ſubject to bowel complaints, and to ſlight palpitation of the heart.

CASE XII.

The two following caſes are examples of genuine ſaturnine colic, and admiſſible therefore, though the event of them is ſtill undecided.

I attended Mr. C—, a reſpectable tradeſman, aged between 60 and 70, three or four years ago. He complained of a conſtant pain and uneaſineſs in the bowels. Suppoſing it a common caſe of obſtruction, (the obſtinacy of which cannot be readily conceived by thoſe, who have not experienced them) I preſcribed principally aperient medicines. But though theſe were purſued with ſufficient ſteadineſs, the relief was ſo little and the diſeaſe became ſo formidable, that another phyſician was conſulted. He ordered, among other medicines, pretty powerful opiates, and with good ſucceſs; the patient becoming relieved ſo much, as to be able to purſue his uſual occupations. However, the benefit proved but temporary: he ſuffered frequent relapſes; and in ſpite of much advice and a multitude of medicines, the diſeaſe became daily more formidable.

In Auguſt, 1802, I was again deſired to attend him, though with little hope of rendering him any eſſential ſervice. I had been informed that his pump was of lead, and was therefore prepared to form a more critical judgement of his caſe. I found the pains to be almoſt continual and of intolerable ſeverity. He obtained a little eaſe from lying down on his belly, and forcibly compreſſing the bowels. In the paroxyſms they extended from the ſtomach through the whole canal; in the intervals of comparative eaſe, there was a conſtant pain about the navel, increaſed a little by preſſure. The ſtrength was greatly impaired, the fleſh waſted, the appetite deſtroyed, the ſleep imperfect and diſturbed; the body bound, though great quantities of opening medicines had been unremittingly given for the laſt three or four years. Notwithſtanding theſe very ſevere ſymptoms, there was little fever, except ſome thirſt occaſionally; the pulſe was feeble, but not in the ſmalleſt degree accelerated.

He informed me, he had uſed this water almoſt thirty years; but ſince his illneſs much more plentifully than ever, as other liquors increaſed his thirſt. He had ſuffered the pains eight or ten years; from a ſlight uneaſineſs they gradually increaſed to their preſent almoſt intolerable ſeverity. The paroxyſms had at firſt conſiderable intervals, though never a complete ceſſation of pain. He had often been afflicted with vomitings, ſometimes with diarrhœa, but uſually with coſtiveneſs. His ſufferings had been always more aggravated than relieved by purging, farther than was neceſſary to obviate coſtiveneſs.

He has now diſuſed the water nearly five months. It has been neceſſary to uſe opium largely: he has borne it well to the extent of ſix grains daily. The pains are leſs ſevere and he has been enabled for a conſiderable time to enjoy comfortable nights. But the ſtrength has become more and more depreſſed, ſo that it ſeems more doubtful than ever, whether it will be poſſible for a conſtitution ſo much exhauſted to overcome the morbid force, which has now been accumulating almoſt thirty years in the ſyſtem. The ſmall hope that remains is founded on the appetite being a little improved, within theſe few laſt weeks.*

CASE XIII.

Mr. Wm. C—, the ſon of the perſon, whoſe caſe I have juſt deſcribed, has lived in the ſame houſe the greateſt part of his life. He has never had ſtrong health, and has now ſuffered pains of the bowels about eight years. I need not enter into any detail, ſince his caſe preciſely reſembles that of his father, except that it is leſs ſevere. If therefore the recital of the ſymptoms be not enough to prove the origin of the ſufferings of the father, the diſeaſe of the ſon puts it beyond diſpute. To the pains of the bowels are alſo joined a heat of the ſtomach, occaſional palpitation * of the heart, and pains of the limbs, principally of the ſuperior extremities: after the pains the hands are very weak.

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* Since this was written, this patient is dead. I wiſhed much to examine the body; but I was not permitted.

This patient obſerves that the pains are moſt ſevere when the ſtomach is empty: eating relieves it or removes it. This circumſtance (which is common to theſe ſaturnine pains) is very contrary to the courſe of bowel complaints from obſtruction, repletion, and indigeſtion; and, if joined with

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* The palpitation of the heart is, though not univerſal, the moſt frequent ſign of ſaturnine irritation of any that has occured to me. It is to be met with, either without the colic, or joined to it. I have not found it noticed in any of the Engliſh writers I have conſulted. However, it is enumerated among the ſigns of the Rachialgia Saturnina by Sauvages, in his deſcription of this complaint, taken from Zeller and Ilſeman. 'Anxii inſigniter toto temporis decurſu erant, quam anxietatem adauxit horrida et inſignis cordis palpitatio.'

the abſence of fever, and the diſpoſition to ſpaſmodic and nervous ſymptoms, may aſſiſt us in diſtinguiſhing theſe affections.

Since he has diſuſed this water, the pains of the inteſtines begin to decline, and the general health is evidently improved. But as the ſtomach is relieved, the pains of the arms have increaſed in ſeverity.

Mrs. C—, the wife of the elder Mr. C. has uſed the water, as long as her huſband. She is the younger of the two. Her health has been very feeble, but ſhe has no complaint, which can be directly traced to the ſame ſource.

CASE XIV.

A married lady had been afflicted for two months with pains of the ſtomach of extreme ſeverity. The firſt attack was trifling; it had been accompanied with a ſlight degree of jaundice, which however ſoon diſappeared. It always came on after going to reſt in paroxyſms, which laſted the greater part of the night. During theſe paroxyſms there was much ſickneſs, and a copious eructation of a frothy liquor. The intervals between the paroxyſm were of uncertain duration: ſhe never ſuffered them but once for two ſucceſſive nights. In the intervals ſhe appeared in perfect health; without the ſmalleſt degree of fever; there were neither thirſt nor head-ach, and the urine was natural.

This lady had been in the habit of drinking water kept in lead, occaſionally for her whole life. She now uſed it in the worſt form the greater part of three days each week; namely, out of a deep well, which, in the parts of the week ſhe was abſent, was little uſed.

I deſired her to diſcontinue it. For a fortnight after it had been no longer uſed, the paroxyſms returned in the ſame manner as before, and with equal ſeverity. But after this time they have not once recurred; and it is now two months ſince they have ceaſed. During this time ſhe has had pains, which have been referred to the back, in paroxyſms alſo, and laſting a few hours. They have been trifling in degree, when compared with her former ſufferings.

The medicines uſed in this caſe were of the moſt ſimple nature. A few gum pills joined with aloes, and ſmall quantities of Epſom ſalt, were all that was given. Opiates were attempted in a moderate doſe; but they failed to relieve the pain, and it was not thought adviſeable to increaſe the quantity.

The water has not as yet been diſcontinued three months. It is evident that the real ſeat of the pain, which is referred to the back, is the ſtomach. It is principally felt a little below the left ſcapula, is increaſed by a deep inſpiration, and is relieved by parting with flatulence, and by the uſe of the pills, the action of which muſt be principally upon the ſtomach.

This relation affords us great encouragement to hope, that the ſevereſt ſymptoms of ſaturnine diſeaſes may not prove very formidable, if rightly underſtood, and properly treated on their firſt appearance. It gives us reaſon to apprehend, that their great obſtinacy chiefly proceeds from the irritation being kept up by freſh quantities of poiſon, after diſeaſe has been formed.

There is a diſeaſe, endemial in Northern countries, which the Scotch call vulgarly the *water-braſh:* it is the *Pyroſis*

Suecica of Sauvages, or ſimple *Pyroſis* of Cullen. Linnæus aſſerts that one half of the inhabitants, male and female, of the Lapland mountains are afflicted with it.* Engliſh phyſicians meet with it ſo ſeldom, that we ſcarcely hear its name mentioned; nor have I ever obſerved it, except it be in this and one other caſe, which I believe to be ſaturnine.† The deſcription given of it by Cullen ſo perfectly reſembles the caſe I have juſt related, and the general courſe of the pains excited by lead, that I cannot but ſuſpect that its origin muſt be ſought for in the action of this poiſon. It is deſcribed by him as a pain at the pit of the ſtomach with a ſenſe of conſtriction, as if the ſtomach were drawn towards the back: after ſome time, it brings on an eructation of a thin watery fluid. It is often very ſevere, and more uſually comes on when the ſtomach is empty; when it has once taken place, it is ready to recur occaſionally for a long time after; finally, no treatment has been found ſerviceable, except relieving the pain by opium.* In all theſe points, the analogy between this and ſaturnine diſeaſe is ſtriking and obvious.

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* Sauvages, Noſologia Methodica, Vol. 2, p. 84.

† In ſaying this, I mean only when it has been in that exquiſite degree, as to deſerve to be claſſed under a peculiar denomination. I think it highly probable, that what we familiarly term *cramp in the ſtomach* is frequently the ſame diſeaſe, excited by the ſame cauſe, or at leaſt occaſioned by noxious matter received into the ſtomach.

That, in the *pyroſis,* the action of the poiſon is peculiarly determined to the ſtomach is perhaps owing to the qualities of the vehicle, in which it is applied. What then is this vehicle? I can conjecture no other than the ſpirits diſtilled from oats, which is called whiſky, in the uſe of which the inhabitants of the northern countries are known greatly to indulge. This ſpirit, moſt probably, is frequently diſtilled through worms of which lead is an ingredient. I apprehend that if theſe impure ſpirits are uſed undiluted, the ſtomach will be affected with pain, which the inteſtines may eſcape.

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* Cullen's Firſt Lines. Vol. 4. Art. Pyroſis.

The Laplandlers are likewiſe ſubject to colic pains of extreme ſeverity.* Theſe they aſcribe to certain worms, which are found in the ſtagnant water, which they are obliged to drink in the ſummer months, when they quit the mountains, and inhabit the woody parts of their country. This diſeaſe terminates in a flow of ſaliva. It is known, that lead occaſionally excites a ſalivation like mercury. It is much more probable, that the colic is cauſed by the ſpirits uſed to correct the water, than by theſe worms, or any bad qualities of the water itſelf. The Laplanders, it is true, diſtil no ſpirits, their country hardly producing grain of any kind. But they are abundantly ſupplied by their neighbours, and ſo much attached to the uſe of ſtrong liquors, that a bottle of brandy is the cuſtomary preſent, exacted daily from the young men by the fathers of their intended brides. The ſpirits, that are uſed among this rude people, cannot be ſuppoſed to be prepared with the ſmalleſt attention or nicety.

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* Linnæi Flora Lapponica, p. 69.

CASE XV.

In December, 1802, I viſited Miſs W—, a maiden lady of middle age. She has uſed a water of this kind the greater part of her life, which I found to be much tainted. She had always been a ſufferer from complaints, which were called nervous. Now had ſhe been afflicted about ſix weeks with vague pains in different parts of the body, leaving a great ſoreneſs in the affected parts, after they had ceaſed. The ſuperior extremities were principally, but not excluſively affected, and particularly, about the inſertion of the deltoid muſcle, the pain was ſuch, as if the arms were breaking aſunder. There was likewiſe ſo great a weakneſs of the hands and arms, that ſhe was unable to raiſe a tea-cup to her mouth. She had never ſuffered any ſevere pains of the ſtomach or bowels.

This appearance is ſo perfectly that of ſaturnine palſy, that it is impoſſible to entertain a doubt of it's true nature. But the hiſtory, which this lady gave me of the caſe of her father, is ſtill more intereſting and inſtructive. He had uſed water of the ſame well, raiſed by a leaden pump (which was finally worn out in the time of the daughter, and a new one put down by herſelf,) for at leaſt ſixty years of a life, that was extended to the advanced period of ſeventy ſeven years. But though he attained to this great longevity, he had ſuch a weakneſs of the hands, that, like his daughter, he was unable to raiſe a cup to his mouth, except by the aid of both; nor was he ever, in her remembrance, exempt from this infirmity. It was attributed to an accident, which had injured the brain. I do not think it in the leaſt neceſſary to uſe any arguments to refute this opinion, or to eſtabliſh my own.

Since therefore it is certain, that ſome of theſe ſolutions are ſufficiently ſtrong to produce the ſaturnine palſy, we can not be ſurpriſed at the invincible obſtinacy, with which this malady often reſiſts every effort to remove it. Many hoſpitals are ſupplied with water which paſſes through lead; this may be of no great conſequence in the cure of the generality of diſeaſes, which are received in them; but it renders them wholly unfit for patients labouring under this claſs of diſorders.

CASE XVII.

Though the following caſe is not one of a diſeaſe excited by water, it is ſo cloſely connected with this enquiry, that I think it proper to admit it.

In December, 1802, I viſited Mrs. B—, the wife of a farmer, a perſon advanced in life. She had ſuffered pains of the bowels about eight years. The pain was of extreme ſeverity, affecting the whole canal, and attacking in paroxyſms. It was relieved by preſſure on the abdomen. During the intervals, there was always an uneaſineſs of the bowels. She was better after food, than when the ſtomach was empty. There was no fever; the urine was pale, as in hyſterical women.

Theſe paroxyſms came on with ſuch a violent tremor, that three people were neceſſary to hold her. The attacks alſo left a tremor on her for ſome time: at my ſecond viſit I perceived a ſhaking of the head, which ſhe had not, when I firſt ſaw her. She had alſo in the beginning of the paroxyſms an ejection of a watery fluid from the ſtomach, as in the diſeaſe called *pyroſis.*

This diſeaſe I have no heſitation in pronouncing to be purely ſaturnine. The only way, in which I can diſcover the poiſon to be introduced, is by meat ſalted in a leaden trough. I ſhall prove in the ſequel, that common ſalt diſſolves lead very abundantly. Indeed, I believe that there is a pretty general ſuſpicion of the noxious qualities of theſe troughs, on which account they are much leſs uſed than formerly. This is one of the caſes, where common obſervation has anticipated ſcientific enquiries, or, to ſpeak more properly, is in contradiction to the deductions, which have been hitherto formed from them.

CASE XVIII.

Towards the end of the ſame month, I attended Mrs. H—, a widow woman in the decline of life. She had uſed one of theſe pumps almoſt five and twenty years, in the water of which minute portions of lead were readily detected. She had now been afflicted about half a year with pains of the bowels of great ſeverity; but with uneaſy ſenſations in theſe parts for a long time before. The abdomen was hard and unyielding to preſſure, like a board; and there was no effectual inteſtinal evacuation. The urine was ſcanty; the countenance ſallow. Notwithſtanding the extraordinary tenſion of the abdomen, ſhe felt relieved after her meals. Beſides the diſorder in the abdominal viſcera, for the laſt twelve months ſhe had ſuffered very ſevere pains in the arms, exactly ſimilar to thoſe of the other patients already deſcribed.

It cannot be expected, that my opinion of the nature of theſe two laſt caſes can as yet have been corroborated by the advantages derived from a change of habits. I am perſuaded, that thoſe who poſſeſs a critical judgement in theſe matters will think the hiſtory of each of them is too plain, to make any corroboration neceſſary. What additional confirmation it has been poſſible for it to receive, has been fully conferred already: I mean, that the medicines adminiſtered under the conviction that the diſeaſes are of ſaturnine origin, have produced as beneficial effects, as can be expected in the preſent ſtage of the diſorders.

CASE XIX.

Whilſt theſe ſheets were ready for the

preſs, a lady, who three or four years ago quitted the neighbourhood of Warwick, communicated to me an event, ſhe had herſelf experienced.

After her removal to her new houſe this lady never enjoyed good health. Nor was ſhe the only ſufferer: ſeveral ſervants of the family found their health impaired. But, in the courſe of the laſt year, ſhe found her indiſpoſition wear away; and the family in general became healthy. She was quite at a loſs to account both for her illneſs and her recovery, till accidentally informed of my opinion of the unwholſomeneſs of water, which had been kept in contact with lead. It appeared, that previous to her recovery, pipes of this nature had become worn out, and in conſequence had been removed, and others of a different kind put down in their place. It is probable that they had been uncommonly noxious, as from the ſituation of the houſe, the water is raiſed through the great height of two hundred feet.

SUCH is the reſult of my own experience, and of a few authentic facts which have come within my knowledge. I think it eſtabliſhed by theſe obſervations, that the ſolutions of lead by ſpring water are ſufficiently powerful to excite every one of thoſe ſymptoms, which are allowed, by the firſt medical authorities, to be the genuine and ſpecific offspring of this poiſon. Theſe are the peculiar and exceſſive pains of the ſtomach and inteſtines, ſevere muſcular pains principally ſeated in the fore arms, and the paralytic weakneſs of the limbs, particularly of the hands and arms. Beſides theſe, ſome other forms of diſeaſe have, I hope, been fully and ſatisfactorily traced to the ſame exciting cauſe. Some of theſe muſt as yet be deemed anomalous, as not being received into the eſtabliſhed claſſes of ſyſtematic writers.

I cannot but conclude, that lead ought never to be brought into permanent contact with water, which is intended in any form to be received into the human body.

I might adduce very many other inſtances of diſeaſe, which I believe either to have entirely originated, or to have been greatly aggravated by the ſame cauſe. I am particularly convinced that it gives a ſtrong diſpoſition to apoplexy. Many paralytic tremors, obſtinate conſtipations, perpetual vomitings, tympanies, tumors of the abdomen in females, glandular ſwellings and ſchirroſities have I believed to have been ſo cauſed, exaſperated or rendered fatal. But I am unwilling to diminiſh the weight of what I apprehend to be evidence, as full and as ſtrict, as the nature of the caſe can admit, by wandering into the field of conjectural ſpeculation. This evidence, be it conſidered, is collected from opportunities of obſervation, which are far from extenſive; and which the ſhort time, during which I have ſuſpected the very exiſtence of ſuch an evil, has rendered ſtill more contracted. Thoſe, who poſſeſs greater advantages than myſelf in this reſpect, will, I doubt not, make the proper uſe of them. I am perſuaded, that they cannot overthrow the deductions I have made. I wiſh they may be enabled ſo to limit and to modify them, as to prove the evil, I have attempted to expoſe, to be of much ſmaller magnitude, than I am inclined to eſteem it.

Experiments.

IT remains that I relate the experiments, which prove the ſolvent power of ſpring water. To theſe I ſhall ſubjoin what other remarks I have been enabled to make on its compoſition. The laſt are in a very unfiniſhed ſtate. They might perhaps have been rendered leſs imperfect, had I not thought it incumbent on me principally to occupy myſelf in examining a great variety of waters, which had been kept in contact with lead, from different parts of the country. The number of them which, I have ſo examined, is now upwards of eighty. The time this inveſtigation has occupied, and the trouble it has given me is my excuſe for preſenting a part of this enquiry in a ſtate, with which I cannot but be diſſatisfied.

I. METHODS OF DETECTING THE LEAD,

1ſt. BY THE ACTION OF SULPHURATED HYDROGEN.

The ſubſtance, which decompoſes the greater part of metallic ſalts, and is principally uſed to detect metallic matter, is a ſolution of ſulphurated hydrogen gas * in diſtilled water. This ſolution added to the ſolution of any common ſalts of lead, as the acetite, or the nitrate of lead, precipitates the metal. The colour of the precipitate is a brown, approaching to blackneſs. To avoid circumlocution, I call this liquor *the teſt.*

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* I uſe this term according to the received theory. But Dr. Prieſtley paſſed the ſteam of water over melted ſulphur; and by this proceſs he obtained merely hydrogen gas. If this ſubſtance contain no other element than ſulphur and hydrogen, ought it not to be formed by this proceſs? See Prieſtley's Experiments and Obſervations. Vol. 1. p. 203.

Lead, if diſſolved by water, cannot be combined in the manner of one of theſe ſalts. If the water contain ſulphuric acid, it would precipitate the lead contained in ſuch ſalts; accordingly, a water can hardly be found in which the ſmalleſt portion of a common ſalt of lead does not immediately form a cloud. That the teſt detects nothing in theſe waters is only ſimilar to the failure of the ſulphuric acid to ſeparate the lead.

I put a little muriate of lead into ſome common hard water. It was decompoſed as faſt as it diſſolved, nor did the teſt detect any thing, after they had been kept in contact ſome days.

Water then, which is rather hard, cannot preſerve its tranſparency, if a ſalt of lead be added to it. If the metal be diſſolved at all, it cannot be by the immediate action of an acid, and we muſt ſearch for it by other proceſſes, than the application of the common re-agents. I have found it in the precipitate made from the waters by the common alcalies, as the carbonate of potaſh or of ſoda.

In operating on theſe waters, I have diſtinctly noticed four different appearances.

(A) The teſt forms a dark cloud with the precipitate, rediſſolved in nitric acid.

(B) Though it forms no cloud, the precipitate itſelf becomes darkened by the teſt.

(C) The teſt forms a white cloud, with the precipitate treated as in (A). Theſe two laſt appearances may be united.

(D) The teſt neither forms a cloud, nor darkens the precipitate.

(E) In the caſes (B, C, D,) heat the precipitate, in contact with an alcaline carbonate, to redneſs, diſſolve out the carbonate by water, and treat the precipitate as in (A); then the teſt forms a dark cloud with the ſolution of the precipitate. In theſe experiments it is neceſſary that the acid uſed to rediſſolve the precipitate be not in exceſs; if it ſhould ſo happen, the exceſs muſt be ſaturated, before the teſt is applied. It is better to uſe ſo little, that ſome precipitate may remain undiſſolved.

(F) Inſtead of the proceſs (E) let the precipitate be expoſed, without addition to a red heat, and then treated as in (A); the teſt will in this caſe detect the metallic matter. But I have not found this proceſs convenient; ſince where I have tried it, it has been neceſſary, that the heat ſhould be ſtrong and long continued. Is the lead in this caſe diſunited from the matter with which it was combined, by increaſing its degree of oxidation? However this be, the proceſs (E), though the moſt complicated, I find to be by far the leaſt troubleſome.

Theſe proceſſes I ſhall illuſtrate by a few examples of waters, ſome of which may be readily procured by ſcientific men, where ſcience is always the moſt flouriſhing; I mean in the metropolis.

Water from an empty houſe—Bridge Street, Stratford-on-Avon. The houſe, from which this water was procured, has been the ſeat of ſo much diſeaſe, as to be an object of common ſuſpicion and converſation. I ſaturated the water with ſulphate of ſoda, and boiled it, in hopes of gaining a depoſit of ſulphate of lead; but none was formed.

Afterwards, I added to the ſame water large quantities of an alcaline ſulphuret; ſome white matter was by this method ſeparated, but I could find no traces of lead; the white matter was the ſame as is formed in ſimilar circumſtances in moſt common hard waters. At length, having arrived at the knowledge of the proceſs (A), I treated in this manner the very ſpecimen, to which the ſulphate of ſoda and alcaline ſulphuret had been added. By this method, a precipitate of dark matter was obtained in abundance. The ſpecimen had been expoſed ſo long to the atmoſphere, that the ſmell of the alcaline ſulphuret was entirely loſt.

I believe the town of Stratford to be much afflicted with this peſt, which may be ſo eaſily got rid of. The waters are very corroſive, and leaden pumps not uncommon.

New River Water. I have examined three ſpecimens of this water. The firſt was from a ciſtern. Proceſs (A) detected lead. But the teſt, recently prepared, did the ſame thing by being added to the water without any preparation. Hence I conclude that the ciſtern was foul. The ſecond ſpecimen was the firſt water drawn from the pipe in a morning. The proceſs (A) gave the ſame reſult in this. The third had been kept in a pipe two days. Here too the proceſs (A) gave the ſame reſult, more ſtrikingly. The teſt added to each of theſe ſpecimens, without preparation, detected nothing.

There was a conſiderable ſediment in the bottle which contained the third ſpecimen. I poured on it ſome diſtilled vinegar;*

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* I cannot procure diſtilled vinegar, which is not ſlightly diſcoloured by ſulphurated hydrogen, though I have rediſtilled it in glaſs veſſels. I added to a portion of it ni-

but the teſt cauſed no diſcolouration. Probably it required the proceſs (E).

Thames Water. I have examined two ſpecimens of this water. The firſt was procured in the ſame way, as the ſecond ſpecimen of the New River water. The proceſs (E) ſhewed a trace of metallic matter, but very feebly. The ſecond had been in a pipe two days. The water had depoſited a ſediment. It ſhewed the appearance of (C), and the teſt by the proceſs (E) cauſed a very ſtrong diſcolouration. The teſt did not diſcolour the water.

I am not certain, that the New River and Thames water are at all retained in the ſhort collateral pipes, which lead from the main trunks. But I underſtand a few of

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trate of ſilver; a few fine flakes were perceptible the ſecond day. It ſeems likely, that muriate of iron is the contaminating matter.

the leaden pipes which were formerly uſed to form the main trunks, which convey the New River water through the ſtreets, are ſtill left. If the firſt experiment with the Thames water is not quite ſatisfactory, the ſtriking difference of the ſecond muſt remove every ſcruple.

Water from St. James's Palace. This ſhewed the appearance of (C), and the proceſs (E) produced the uſual diſcolouration. The water is brought in leaden pipes from Bayſwater, on the Uxbridge road. Though it is collected in a ciſtern at the top of the palace, the teſt did not tinge the water at all.

The water which affected the lady, whoſe diſeaſe is related in Caſe XIV, ſhewed the ſame appearances as this. All the others, which I have known to be the cauſe of injury, had the lead ſo combined, as to be detected by the proceſs (A).

Lea River Water. This water is the principal ſupply of the pariſh of Hackney. It had been retained in a pipe ſome hours. It ſhewed the appearances of (D). By the proceſs (E) the ſolution of the precipitate was ſtrongly diſcoloured.—There was a depoſit in the bottle, which I ſeparated, and I dropped on it a little diluted nitric acid, which diſſolved it without effervеſcence. The teſt both tinged the ſolution, and darkened the part of the ſediment which remained undiſſolved.

(G) Beſides theſe varieties, which are common, I have met with two ſpecimens, which betrayed the ſaturnine impregnation in a manner very ſtriking and pleaſing. After the addition of the teſt, I dropped a little ſolution of carbonate of potaſh into the phial. The whole body of the water inſtantly became ſtrongly tinged at the bottom of the phial, where it continued tranſparent. At the top, where the water had become cloudy, there was no tinge perceptible. Theſe waters came from neighbouring houſes, where the ſoil is calcarious. I thought this appearance had been cauſed by the minute quantity of matter, they held in ſolution. But I have not been able to imitate it in others, which are ſofter than theſe. One was drank by the perſon, whoſe diſeaſe is related in Caſe X.

Solution of common Salt. From certain appearances, to be deſcribed hereafter, I concluded that ſalt contains the matter, to the action of which I attribute the ſolvent power of ſpring water. I therefore put ſome ſhots into a phial, containing a ſolution of ſalt in diſtilled water, and kept them in contact ſome days. The teſt diſcoloured the ſolution immediately. This appearance was what I did not expect, and muſt be cauſed partly by the arſenic, which is an ingredient of ſhot. I therefore put ſome ſlips of common glaſier's lead into another ſimilar ſolution. The teſt added to this liquor produced no diſcolouration, though the lead was kept in the ſolution ſome months, with the phial uncorked. But the ſolution, treated by the proceſs (A), plainly evinced that it had taken up a portion of the lead.

A ſolution of the ſame common ſalt in diſtilled water was ſubjected to a ſimilar trial. The teſt produced ſome diſcolouration here; but it was ſo dilute, as to be ſcarcely diſcernible.

Brine from a leaden ſalting trough. I precipitated the matter from brine, in which meat had been ſalted, by carbonate of potaſh, and collected the precipitate on a filter. It was clear, from the ſmell of this ſubſtance, that it partly conſiſted of an animal matter. This matter I expoſed to a red heat, till it ceaſed to yield inflammable vapour. It had now a black coaly appearance, and was treated by the proceſs (A). This was followed by the cuſtomary reſult of a copious dark precipitate.

Dr. Darwin, and after him, Sir G. Baker examined theſe two laſt ſubſtances with alcaline ſulphurets, without obtaining any precipitation. We ſee how little confidence can be placed in ſuch a method of examination. It cannot be doubted, that many animal and vegetable juices may form combinations with lead or its oxyds, which cannot be decompoſed by preparations of ſulphur. Though therefore theſe teſts do not detect any thing when added to milk, cream, or other matters, which it is ſtill too much the cuſtom to keep in veſſels formed of this metal, it does not at all prove that none of the metal has been diſſolved. If there be the ſmalleſt particle of acid formed, it cannot be doubted that the lead will be diſſolved.

In the experiments I have related, it is eſſential that the acid employed be pure. I uſed none but what I had precipitated by nitrate of ſilver, and diſtilled in glaſs veſſels. The teſt alſo ſhould be recently prepared. The gas was made by adding diluted ſulphuric acid to iron filings and ſulphur, united by fuſion.

It muſt be acknowledged, that theſe experiments, though they afford a very high degree of probability of the truth of the poſition I wiſh to eſtabliſh, are not wholly exempt from ſources of fallacy. 1ſt. *Other metals may form a part of the precipitates;* and indeed I propoſe to prove that all ſpring water is metallic. But the other metals are not taken up by the diluted nitric acid, when precipitated by the alcaline carbonates *; and they cannot be ſhewn at all in ſuch minute quantities of water, as I uſe in the proceſſes for detecting lead. In the firſt proceſs (A) two ounces of water I have found to be enough; and for the other (E), I have rarely uſed more than eight, except the precipitate be very minute. 2nd. *Iron may be expected to be found more plentifully in ſome waters.* But it cannot be expected than iron be found in all ſo plentifully, and there is not one, which has been in contact with lead, in which one or other of the proceſſes does not detect metallic matter. Beſides, the ſame water has been occaſionally examined both before and after the contact with lead, with oppoſite reſults, and I have uſed the proceſs (A) upon ſeveral waters, differently circumſtanced, without being able to obſerve any ſigns of metallic matter. I muſt confeſs, however, that there are ſome, in which ſuch ſigns may be obſerved. I have therefore uſed another method, which is

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* See below the obſervation (IV. D.)

2. BY PRECIPITATING THE LEAD BY MURIATE OF SODA.

As muriate of lead is not wholly inſoluble in water, this cannot be applied as a teſt to ſmall portions of ſuſpected water. I therefore collected the precipitate from about three gallons of water. It was of that nature, in which the teſt ſcarcely detects any thing, without the aid of the proceſs (E). I therefore heated it to redneſs with twice its weight of carbonate of ſoda, diſſolved out the ſoda, added nitric acid to the remainder, and ſaturated the ſuperfluous acid. A little of this ſolution gave the uſual indications of lead by the addition of the teſt. But that I might not be deceived by any other metal, I added to it a ſmall quantity of muriate of ſoda, diſſolved in water. The ſolution depoſited a white matter. To enſure a perfect ſeparation, I evaporated the liquor to dryneſs, rediſſolved the ſalts in a little cold water, and filtered immediately. By this proceſs a good quantity of the white matter was left on the filter.

This white matter had the properties of muriate of lead. It diſſolved in acetic acid. I precipitated it from this ſolution, and treated the precipitate as in proceſs (E), by which I obtained a dark matter in great abundance.

A ſmall quantity of the white matter eſcaped the action of the acetic acid. It was, probably, ſulphate of lead. It cannot be ſuppoſed, that the common ſalt, which was uſed, was quite free from the ſulphuric acid.

In this experiment there could be no deception from iron or any other metal.*

Water from St. George's hoſpital, Weſtminſter. Dr. Heberden ſent me the precipitate of three gallons of this water. It comes from the Chelſea water works, the pipes of which are iron, but it is diſtributed to different parts of the buildiug through leaden pipes, in which it muſt be retained. The precipitate was of a brown colour. The proceſs (I. A) yielded a dark cloud and abundantly. To a void deception from iron, I ſubjected it to the experiments juſt related (2). By this method I obtained a ſmall portion of muriate of lead, as I preſume; for unluckily it was loſt, and ſo not ſubjected to a deciſive trial. The quantity was much leſs than what was obtained in the proceſs (2), perhaps becauſe I neglected to ſubmit this precipitate to heat in contact with an alcaline carbonate.—The ſame fact may be proved

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* Iron is ſo univerſally diffuſed, that it may well be expected that the proceſſes I have uſed may detect quantities ſo minute, as to elude the action of re-agents, merely from the great tenuity of the particles, previous to precipitation. If its quantity is large, it is an additional proof of the juſtneſs of the principles laid down, and that they may be extended to other metals.

3. BY THE REDUCTION OF THE METAL.

This proceſs, which is the moſt ſatiſfactory of all, is alſo very eaſy, were it not for the trouble of collecting a quantity of precipitate, large enough to operate upon. However, I collected the precipitate from about fifty gallons of water, which the proceſs (I. A) indicated to contain lead in ſolution; this I mixed with its own weight of an alcaline carbonate, and expoſed it to a heat ſufficient to melt the alcali. On breaking the crucible I found a little globule of lead reduced at the bottom. Its weight was about two grains; it was nearly the whole, which the water had contained, as I found by examining the alcali which had been fuſed.

We are informed ‘that a meaſure of ‘wine, called the menſura Wirtenburgica ‘major, which Reiſelius eſtimates at ſixty ‘four ounces, ſcarcely contained half a ‘grain of litharge *.’ If we call this meaſure half a gallon, which I ſuppoſe it nearly is, and make ſome allowance for the increaſe of weight, which lead acquires by its converſion into litharge, we may fairly ſuppoſe fifty gallons of ſuch adulterated wine to contain forty grains of lead. We may ſay therefore, upon a rough calculation, that the wine took up more than twenty

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* Medical Tranſactions, vol. 1. p. 241.

times the quantity, which had been diſſolved in the water*.

II. ON THE TIME REQUIRED FOR THE SOLUTION OF LEAD.

It ſeems probable from the experiment with the Lea River water, that a few hours are enough to impregnate water with a quantity of lead, that may be rendered ſenſible to the teſt. To put this queſtion beyond a doubt, I kept a piece of lead in ſome water from my own pump near twenty four hours. The proceſs (I. A) produced a very evident diſcolouration. The ſame proceſs was uſed with ſome of this water, with which lead had not been in contact, without any effect. I had tried the ſame water before, after it had been kept near twenty four hours in a tinned boiler, to diſcover whether the water had diſſolved any portion of the internal covering of the boiler. I could not diſcover that it had. However, this experiment ought to be repeated with water, that has been kept in different veſſels, and particularly when they have been recently tinned.

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* When I ſaid, at page 53, that the quantity diſſolved in this inſtance is little more than a *tenth* of that contained in ſophiſticated wine, the reader will ſee that I committed an error in the calculation.

THE following is a liſt of the waters, which I have examined. The columns A and E indicate the proceſſes neceſſary to the detection of the lead in each.

	A	E	
London and Hackney, —	2	3	5
* Cambridge, — — —	4	6	10

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* The four firſt of theſe ſpecimens were from St. John's College Kitchen, Hobſon's conduit, Emanuel pump and

	A	E	
* Oxford,	3	7	10
Huntingdon,	5	6	11
Worceſter,	2		2
† Birmingham,	2		2
Coventry,	1		1
Derby,	1		1
Shipſton,	1		1
Banbury,		1	1
Tettenhall, Staffordſhire,	1	3	4
Chapel Aſh, Do.		1	1
New Hall, near Birmingham,		1	1
Wolverhampton,		3	3
Stratford-on-Avon,	4	1	5
Warwick,	10	2	12

Mr. Tott's. The ſix others from Addenbrooke's hoſpital, a common pump near St Mary's church, Trinity conduit, Mr. Thackeray's, Mr. Aſprey's and Mr. Morton's.

* I had two others, on which the proceſs (A) had no effect. An accident prevented further examination. I ſhould have particularized each ſpecimen, but my friend neglected giving me this information.

† One of theſe ſupplies the Creſcent.

	A	E	
Barford, Warwickſhire,		1	1
Kenilworth, Do.	1		1
Wellſbourn, Do.	3		3
Snitterfield, Do.	1		1
Alveſton, Do.	1		1
Berkſwell, Do.		1	1
Grove Park, Do.		1	1
Budbrooke, Do.	1		1
Hampton Lucy, Do.		1	1
Pillerton, Do.	2		2
Stourbridge,	1		1
Hampſhire,	1		1
Leiceſter,	1	1	2
	40	47	87

III. ON THE WHITE MATTER, FOUND ON THE SURFACE OF LEAD.

Had the mode, in which this matter is formed, been well obſerved, it would hardly have been made a queſtion, whether the water diſſolves the lead or not. For this matter is not a mere corroſion or oxydation of the ſurface of the lead; but it is a depoſit from the water, which ſettles upon the metal. As the lead therefore wears out, and is to be found in the compoſition of this matter, it muſt have been diſſolved, and afterwards precipitated from the water.

(A) I immerſed pieces of lead in two different ſpecimens of common pump water; the water was kept in tranſparent glaſs decanters, and its ſurface was ſeveral inches above the lead; finally, the atmoſphere was not wholly excluded, that the circumſtances of the experiment might more nearly reſemble thoſe of open ſprings. The appearances in both ſpecimens were nearly the ſame, except that in one the ſurface of the lead was but ſlightly tarniſhed; on the other a dark calciform matter was depoſited. But in each, after ten or twelve days, a cryſtalline matter began to be depoſited on the glaſs at the ſurface of the water, and this gradually increaſed ſo much, that the glaſs at this part had at length an incruſtation of this matter all round; the water itſelf became covered with a pellicle, which fell to the bottom, and was repeatedly renewed by the ſeparation of freſh matter. The lead contracted white ſpots, and where it was in contact with the glaſs, the decanter became ſtained by the oxydation of the lead. This ſtain ſpread upon the glaſs, the place of contact being the central point.

(B) Into the firſt of theſe waters I dropped a ſolution of ſulphuret of lime, which cauſed no precipitation; but I detected lead in the precipitate, which, by conſidering the way in which it had been depoſited from the water, was a convincing proof that the water muſt have held the lead in ſolution; and indeed it was the only one, which for a long time I poſſeſſed.

The other I examined with more accuracy. (C) I impregnated a portion of it with ſulphurated hydrogen gas. The water was not diſcoloured, but a few fine particles which had been hardly viſible, became dark and ſubſided to the bottom. (D) I paſſed another portion through double filtering paper, and then treated it as the former portion, without cauſing the ſmalleſt diſcolouration.

The experiments of Sir G. Baker were then perfectly correct; and doubtleſs if, as is aſſerted in Mr. Henry's Epitome, this teſt ſenſibly diſcolours water, that has been diſtilled through a leaden worm, the appearance muſt be cauſed by minute portions of an oxyd of lead, which are abraded and float in the fluid, as in the experiment (C).

(E) Still the water in which the lead had been kept may be ſhown to contain the metal abundantly. 1. I added carbonate of potaſh to the portion (D), and the precipitate which fell become diſcoloured. 2. I collected ſome precipitate from a freſh portion, which had been properly filtered. To detect the lead I found it neceſſary, in this inſtance, to uſe the proceſs (I. E). The dark matter, which was obtained by this method, was ſo copious, that a large proportion of the whole precipitate ſeemed to be lead. The greateſt part of the contents of the water had been ſeparated by the contact of the lead, aided perhaps by the action of the atmoſphere. (F) Some of the matter, which had ſeparated ſpontaneouſly, was now diſſolved in nitric acid. It was ſo much loaded with metal, as to communicate a ſweet taſte to the ſolution, and poſſeſſed every property, which characterizes the ſalts of lead.

(G) But ſuch is the great variety of the properties of ſpring water, that even theſe appearances (F) are not conſtant. I procured ſome of the matter collected at the bottom of a ciſtern, in which pump water had ſtagnated. 1. I diſſolved it in nitric acid; the ſolution was made with a great efferveſcence; it had a green colour, and a vegetable ſmell: the teſt added to this ſolution produced no diſcolouration. 2. I precipitated the ſolution, and collected the precipitate: it had a cryſtalline ſtructure, with ſome brilliancy. I rediſſolved it in nitric acid; the ſolution had loſt its green colour, and had the taſte of nitrate of lime. I again applied the teſt; but with no better ſucceſs, ſince it gave no indication of metallic matter. 3. I now uſed the proceſs (I. E), and with the uſual conſequences of obtaining a dark precipitate.

IV. ON THE METALS CONTAINED IN SPRING WATER.

It remains, that I offer ſome conjectures on the ſubſtances, which communicate to ſpring water the power of diſſolving lead. I believe it to be a compound ſalt, the baſis of which is manganeſe, iron, and, perhaps, a little nickel. The acid, to which they are united, I preſume to be the muriatic, in a high degree of oxygenation.

Some years ago I detected a ſalt of this nature in the medicinal ſprings at Leamington Priors, near Warwick*; and at the time ſuppoſed it peculiar to the water of theſe ſprings: but, by inſtituting analogous experiments on other waters, I find that a ſalt with ſimilar properties is widely diffuſed through all common ſpring water; and I believe, that if it is found in mineral waters, this is chiefly owing to their receiving into their compoſition the common ſpring water of the country.

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* See my analyſis of two mineral ſprings at Leamington Priors, in the Mancheſter Memoirs. Vol. 5.

(A) Put into any common ſpring water a ſolution of the tartarites of ſoda or potaſh; in no great length of time, a precipitate will be formed, which has a cryſtalline ſtructure, and is beautifully brilliant, if viewed by candle light, or in the ſunſhine.

Almoſt every ſpring water, and all the mineral waters I have examined, ſhow this appearance. The celebrated waters of Bath, and Harrowgate do it abundantly. A ſolution of common ſalt in diſtilled water has likewiſe the ſame effect, probably becauſe this ſubſtance has been diſſolved and mixed with common ſpring water. Rain water has no ſuch effect, and a few land ſprings, which ſeem to be little more than rain water, filtered through a bed of ſand, or of a ſoil, from which it can extract nothing, alſo fail to produce it. The pure water of Malvern wells has not this property; and there is a very pure water at Rock Mill, within a mile of Warwick, which is likewiſe without it.

(B) Boil ſome of the water to get rid of the carbonic acid, and add to it a portion of lime water; laſtly expoſe it to the air to precipitate the lime: now the tartarites fail to produce any cryſtalline precipitate. The metallic matter of the water is ſeparated by the lime, and may be found in the precipitate formed by it, but in too ſmall quantities to determine its nature.

(C) The alcali, which had been fuſed in the proceſs for reducing the metal, (I. 3.) where the heat had been greateſt, by the ſide of the crucible, was of a green colour, and of a reddiſh brown towards the internal parts. When the alcali was entirely diſſolved, there remained a yellow powder, inſoluble in nitric acid even by long digeſtion. There was alſo a white flakey matter mixed with it, in conſiderable abundance, which was likewiſe inſoluble in nitric acid, of the nature of which I am ſtill greatly in doubt.

(D) If a conſiderable quantity of the precipitate from common water, by an alcaline carbonate, be diſſolved in diluted nitric acid, a ſmall quantity of a peculiar matter remains undiſſolved. It is of a bluiſh colour, and as it may be obſerved to be of the ſame colour in different waters, and to be in proportion to the quantity of precipitate uſed, it is evident, that this is not an accidental impurity, but an eſſential ingredient of the water. Where minute quantities are uſed, this matter would paſs wholly unnoticed.

This proceſs preſents a ready method of collecting the metallic part of ſpring water. I therefore boiled about forty gallons of water with two or three pounds of carbonate of potaſh; collected the precipitate; boiled it with diluted nitric acid, which I had added in exceſs, and collected on a filter the part which had remained undiſſolved. It was not now blue; its colour was changed, perhaps by the heat; it had exactly the appearance of the powder left in the proceſs (B), but unmixed with the flakey matter. Its weight was twelve grains.

(E) To render it ſoluble in acids, I mixed it with twice its weight of dry carbonate of ſoda, and a little charcoal powder; put it in a crucible, covered it over with decrepitated muriate of ſoda, and expoſed it to a ſtrong heat. The whole was melted, and the flux had received a deep green tinge.

(F) 1. It now diſſolved readily in nitric acid; the ſolution was at firſt green, but become yellow by contact with the atmoſphere. 2. I added an alcaline carbonate and boiled it; by this I obtained the metallic matter ſeparate. As I expected both from my experiments with the Leamington waters, and from the obſervation (C), that it contained manganeſe, I uſed for its diſcovery the proceſs pointed out by Vanquelin as unexceptionable, namely ſolution by carbonic acid. 3. I digeſted it in a ſolution of this acid, and alſo with a ſuperſaturated carbonate of potaſh. By theſe means, I extracted an aſh coloured powder. I expoſed it to a red heat; but it did not become black, as I expected. Unluckily, the greater part of it was loſt in operating on it:

what remained I again fuſed in contact with carbonate of potaſh. By this treatment it communicated a beautiful greeniſh blue tinge to the potaſh, ſurrounded by an edge of a violet colour. It cannot be doubted then, that manganeſe enters into this powder, though mixed with ſome other metal. I think iron ſtill forms a conſiderable part of it, notwithſtanding the method, by which it had been obtained. After ſeparating it from the potaſh, it gave no tinge to a globule of borax, except by a long continued heat in a platina ſpoon; when the flux became of a faint yellow. The colour was heightened by nitre, but I could not diſtinctly obſerve the peculiar tinge imparted by manganeſe. Theſe trials were of courſe made by the blow-pipe.

(G) Iron may be now eaſily extracted. Rediſſolve the part, which reſiſted the ſuper-carbonated potaſh, in nitric acid, and again precipitate with carbonate of ammonia. A white powder falls, which becomes yellow by contact with the atmoſphere, and is a pure oxyd of Iron.

(H) After the ſeparation of the iron, I added to the ſolution (G) ſome of the teſt. The ſolution became turbid, and of a colour approaching to olive-green. This appearance I preſume to indicate nickel, but the quantity of matter ſeparated was too ſmall to be ſubmitted to further trials. *

V. ON THE MATTER WHICH COMMUNICATES TO WATER ITS SOLVENT POWER.

The acid, which keeps theſe metallic ſubſtances in ſolution, I preſume to be the

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* I was induced to make this trial from reading Mr. Howard's intereſting analyſis of the ſtones, which have

muriatic, and I apprehend the ſalts to be in ſo high a degree of oxygenation, as to communicate to the water itſelf ſome of the characters of acidity. This aſſumption is in a meaſure conjectural, and not very capable of ſtrict proof. I have evaporated ſome of theſe waters and find them to abound in a deliqueſcent ſalt, the taſte of which indicates it, not to be the common muriate of lime or magneſia. In my analyſis of the mineral waters of Leamington, I have ſhown how much theſe oxygenated ſalts reſiſt the action of ſulphurated hydrogen, and nitrate of ſilver *, and how they

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been atteſted to have fallen on the earth, publiſhed in the Philoſophical Tranſactions for 1800. I have long believed rain water to contain both iron and ſulphur; if it alſo contain nickel and ſilica, it will be proved (what is evident to reaſon without any proof,) that theſe ſubſtances have been elevated from the ſurface of the earth, previous to their precipitation from the atmoſphere.

* This fact has been ſince confirmed and extended by Mr. Chenevix, in his experiments on muriatic acid, pub-

communicate to thoſe ſprings the power of corroding and diſſolving metallic ſubſtances.

To inveſtigate more minutely the action of ſuch ſalts upon lead, I made the following trial.

(A) I formed an oxymuriate of manganeſe, in the manner I have there deſcribed, and diffuſed it through diſtilled water. The quantity of the metal was ſo ſmall, that the ſolution of the tartarite of ſoda required two days to ſeparate the manganeſe;

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liſhed in the Philoſophical Tranſactions for 1802. My experiments on the generation of the muriatic acid have been repeated, and confirmed by Dr. Woodhouſe, profeſſor of chemiſtry in the univerſity of Pennſylvania. But I have not at all ſuppoſed, as this gentleman apprehends, that ſulphurated hydrogen is the baſe of the muriatic acid. On the contrary, I believe muriatic acid to be a modification of water, nor do I regard the recent experiments of Berthollet as inconſiſtent with this hypotheſis.

then a minute cryſtalline matter was obſerved adhering to the glaſs. In this water I kept a piece of lead ſeveral months. The lead acquired a ſlight yellow tarniſh, like that made by one of the waters, on which the ſame trial was made (III. A); it became ſpotted with a white oxyd at different parts; and where the metal was in contact, a white matter was depoſited on the glaſs, ſpreading from the lead as a central point. Some white ſhining flakes alſo ſeparated and collected at the bottom of the glaſs, which were readily ſhown to be oxyd of lead: in fine, the appearances were exactly ſimilar to thoſe, which had been obſerved in the hard waters, except that there was no cryſtalline matter depoſited at the edge, nor any pellicle formed on the ſurface.

The water itſelf was ſubmitted to the ſame trials, as the natural hard water. The teſt did not diſcolour it: but the precipitate, made by carbonate of potaſh, became diſcoloured, and its ſolution in nitric acid alſo became tinged. However, the quantity of precipitate was ſo minute, that it required two days to collect enough for examination.

VI. THE SILICA OF SPRING WATER.

Beſides the metallic matters, which are ſeparated from ſpring water by the proceſs (IV. D), there is alſo an earth, conſtituting a portion of the precipitate, which remains undiſſolved by the nitric acid. When the metallic part had been diſſolved, there remained a white matter, which was eaſily diſſolved by treating it with potaſh in a ſilver crucible. This part was therefore ſilica.

I ſhall not attempt to indicate the proportion, of theſe different ſubſtances. The whole had, by the fuſion (IV. E), adhered ſo cloſely to the crucible, that it could not be perfectly ſeparated, and ſome part of the crucible was alſo detached by the attempt. But, of the twelve grains of matter, three or four may have been ſilica: of the metallic part, the aſh-coloured powder, ſeparated by the carbonic acid (IV. F. 3), was the moſt in quantity, the pure oxyd of iron (IV. G) held the ſecond place; the quantity of nickel (IV. H) was very minute.

ALL theſe experiments evince how greatly they are miſtaken, who believe ſpring water to be no other, than ſolutions of earthy ſalts, more or leſs diluted. Beſides the ſubſtances I have ſhown it to contain, there muſt be at leaſt one other, which ſtill requires to be ſeparated. As many of theſe waters indicate no metallic impregnation, till they have been treated with alcali, according to the proceſs (I. E), it is evident, that there is ſome ſubſtance, which unites with the metal, and either prevents its union with acids, or its ſeparation from them by ſulphurated hydrogen. What this is I have not as yet learned. Is it a vegetable ſubſtance extracted from decayed plants, or a fixed acid? Without excluding the firſt ſuppoſition, I cannot but ſuſpect the ſecond, and am even much inclined to think it to be boracic acid. If we examine the precipitate from ſpring water, made by alcaline carbonates, it may be frequently perceived to have a cryſtalline ſtructure; and in ſeveral waters, particularly in thoſe, which have been kept ſome time before examination, perfect cryſtals are depoſited, of a rhomboidal form.

Whatever the matter be, which cauſes theſe appearances, it certainly enters into combination with more than one of the principles of the water. Beſides combining with the metals which are accidentally diſſolved; it ſeems to be a part of the inſoluble reſidnum (IV. D); and I have reaſons to believe, that it even combines with the muriate of lead, ſeparated by the proceſs (I. 2). The flakey ſubſtance which reſiſts the nitric acid (IV. C), may be the ſame matter, united by heat with the earths contained in the water; and it may be preſumed that the waters, that cauſed the remarkable appearance, noted at (I. F), were without it. Till the nature of this ſubſtance is aſcertained, we cannot hope to make a perfect imitation of ſpring water, and confirm our reaſonings on its compoſition by ſynthetic experiments.

APPENDIX.

I HAVE ſaid at p. 153 of the foregoing ſheets, that the ſolution of lead in ſpring water gives a ſtrong diſpoſition to apoplexy. The diſeaſe of the arm, which is mentioned in Caſe IV, was a ſymptom, which threatened more to be a precurſor of apoplexy, than the proper appearance of ſaturnine palſy. Since writing the caſes related above, I have received the following, which much confirms the opinion I have advanced. I have had no further communication with the ingenious writer, than informing him generally of the object of my reſearches.

CASE XX.

About two years ago, Mr. W— was afflicted with a violent head-ach, throbbing of the Temples, and general numbneſs of the right ſide. He was ſent to Cheltenham, and returned home completely well, in two months. Laſt ſpring his complaints returned, and I was conſulted. I ſent him to Buxton, where he remained two months, and in that time had recovered from all his complaints. Before theſe ſeizures, he had been remarkably ſtout, and healthy, and active. He is about fifty years old.

Three weeks ago, I was deſired to ſee him again. He had then been afflicted with violent pains of the Bowels for a fortnight before, loſs of appetite and ſtrength, brackiſh taſte in the mouth, and coſtiveneſs. All theſe complaints had been relieved by opening the Bowels and by Opium, but as they frequently recurred, at laſt the very intelligent Surgeon, who attended him, began to ſuſpect, that Lead might be the cauſe of diſorder.

On enquiring he found, that all the water uſed in Mr. W—'s family was conveyed by leaden pipes from a running ſtream, the diſtance of half a mile, and that it was pumped for immediate uſe through a leaden Cylinder. The Reſervoir was Wooden.

Some of this water I have ſent you—Mr. W— is now better, but is affected with a good deal of pain, extending from the wriſt to the elbow of the left arm. I know no particulars of the caſe of Dr. Withering, which I mentioned to you, except that Salivation was ſuppoſed to be produced by Lead.

I remain truly yours,
JOHN JOHNSTONE.

Birmingham, Jan. 27th, 1803.

I have examined this water and think from the appearance it gave with the teſt, (after the uſual preparation) that it is the very worſt I have met with. It was that, which came from Stourbridge.

I have heard that there is, in ſome medical work or memoirs, a caſe of a lady of Coleſhill, who ſuffered from the water of a leaden pump. It was to an enquiry on this ſubject that my friend alludes, in the concluding paragraph of his letter.

I take this opportunity of making the following

Additional obſervation to Caſe XVIII.

I have examined the ſtate of the abdomen of this patient. On the right ſide there has been formed a maſs, which has the appearance of a ſchirrous tumor. It began upwards of three years ago, above the *ilium*, and has been gradually increaſing. The left ſide is of the natural ſoftneſs. But the acute pains of the abdomen are not in, nor ſpread from the tumor; the left ſide, where there is no ſenſible diſeaſe, is as much affected as the other. The Pulſe is ſoft, weak and of the natural frequency.

The ſtomach pains of the lady, deſcribed in Caſe XIV, have quite left her, and the other, whoſe ſituation is related in Caſe XV, informs me, that ſhe has perfectly recovered. Of the preſent condition of the others, I have received no freſh information.

Feb. 26, 1803.

FINIS

Sharpe, Printer, Warwick.

28 JAN. 1929